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AIR-TO-GROUND GUNNERY SIMULATION COMPUTER PROGRAM-PO655

MISSILE AND GUN SYSTEM ANALYSIS BRANCH
WEAPON SYSTEMS ANALYSIS DIVISION

OCTOBER 1976

FINAL REPORT FOR PERIOD
NOVEMBER 1975-JULY 1976

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This gun simulation program is a research contribution which employs a Monte Carlo technique to determine the probability of destroying a rectangular target with air-to-ground gunnery. The effect of correlation of successive aim points is considered and bivariate normal aiming error and ballistic dispersion are assumed. The mathematical derivation, FORTRAN program listing, variable list, flow chart, sample deck set-ups, and output results are included.

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PREFACE

This report documents an air-to-ground gunnery model accomplished during the period November 1975 to July 1976 at the Air Force Armament Laboratory, Armament Development and Test Center, Eglin Air Force Base, Florida. The work was in support of JON 2543-01-10.

The original version of this program was developed by the Operations Evaluation Group, Center for Naval Analyses, Washington, D.C., in August 1969 (Reference 1). Since this time, the program has been extensively modified and updated to include the most modern techniques available.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

J. R. MURRAY
Chief, Analysis Division

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SECTION I

INTRODUCTION

This is a computer program which simulates air-to-ground gun effectiveness against a stationary target. The impact points of the individual rounds are correlated, and a Monte Carlo method is required to determine the probability of hitting a rectangular target with one or more rounds in a single burst. The model assumes that gunnery is a stationary Markov process and that the aiming and ballistic dispersions are independent in the range (along the flight path of the aircraft) and deflection (normal to the flight path in the horizontal plane) coordinates. The guns are assumed to be fixed (as opposed to guns turreted). The strafing aircraft flies at a constant airspeed and dive angle from a specified slant range.

SECTION II

GENERAL DESCRIPTION

This is a Monte Carlo simulation program which determines the probability of killing a ground target from an aircraft equipped with a machine gun firing a single burst of N rounds. The individual aimpoints cannot be specified in advance; therefore, the program assumes that successive aimpoints are correlated (Reference 2). The aimpoints are normally distributed about the center of the target. The program further assumes that ballistic dispersion is present. Thus, the i^{th} round impacts not at its aimpoint but at some point nearby.

The target assumed in the program is the rectangular projection of the real target on the plane normal to the line of flight of the attacking aircraft. Distances are measured with respect to a range-deflection (R, D) coordinate system. The origin is located at the center of the target, and the coordinate axes are parallel to the sides of the target (Figures 1 and 2). In real life the target will seldom or never be rectangular in shape, but the projected target can always be approximated by a rectangle. The target length, ℓ, is measured in the range direction, and width, ω, in the deflection direction. The slant range is denoted by s, c is the aircraft speed, and R is firing rate in rounds per minute. The slant range decreases for each successive round fired, thus increasing the apparent size of the target and causing a corresponding increase in hit probability. In addition to the above, the program inputs include the maximum number of rounds per pass (FN), the number of Monte Carlo iterations to be made (F), the burst length print increment (DN), the maximum standard deviation of the mean (E), the probability that the gun jams (PJAM), the number of gun systems (GUNS), and a time-to-rate table for a Gatling gun effect.

To determine aimpoint error, let (R_i, D_i) be the aimpoint of the i^{th} round, and let (r_i, d_i) be the point at which the round impacts. Further, let s_i be the slant range at the instant the i^{th} round is fired. Then from Figure 2 it can be seen $R_i \cong s_i\alpha_i$ and $D_i \cong s_i\beta_i$; expressing the angles in mils, $R_i \cong 0.001\ s_i\alpha_i$; and $D_i \cong 0.001\ s_i\beta_i$. The program uses the two angles α_i and β_i rather than R_i and D_i. These angles are computed by employing a random number generator. The angle α_i is a random normal variable with mean zero and standard deviation σ_α, and β_i is a random normal variable with a mean zero and standard deviation σ_β. Ballistic dispersion is determined similarly. Two angles γ_i and δ_i are defined so that $(r_i - R_i \cong 0.001\ s_i\gamma_i)$ and $(d_i - D_i) \cong 0.001\ s_i\delta_i$. The angle γ_i is a normally distributed random variable with mean zero and standard deviation σ_γ; s_i is a normally distributed random variable with mean zero and standard deviation σ_δ. The range component of error is considered to be independent

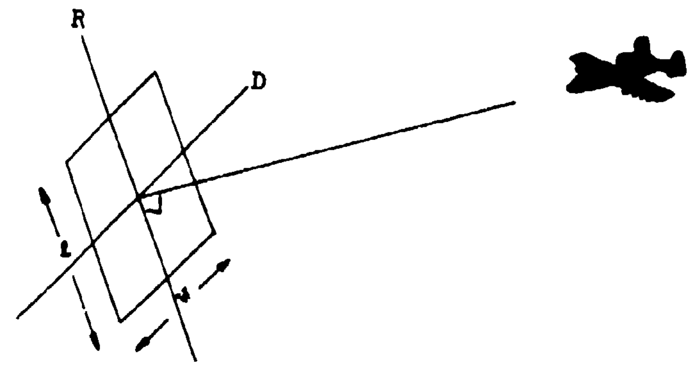

Figure 1. Target Geometry

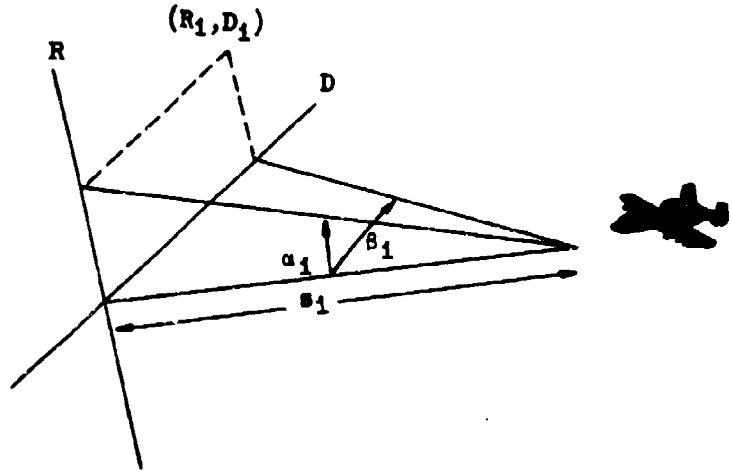

Figure 2. Slant Range Geometry

of the deflection component. Also, for all $i, j \leq N$,

$$E(\alpha_i \alpha_j) = a^{|i - j|} \sigma_\alpha^2$$

and

$$E(\beta_i \beta_j) = b^{|i - j|} \sigma_\beta^2$$

These two relationships characterize the programs correlation feature. The numbers a and b are inputs that determine the correlation between aimpoints. The correlation in range between consecutive aimpoints is given by a, and b is the correlation deflection. The correlation in range between the i^{th} and the j^{th} aimpoint is $a^{|i - j|}$ and the correlation in deflection is $b^{|i - j|}$. If $a = b = 1$, then $R_i = R_j$ and $D_i = D_j$ for all $i, j \leq N$. This occurs in the salvo model where every round has the same aimpoint. If $a = b = 0$, every aimpoint is independent of every other aimpoint. The general case will be when a and b lie between 0 and 1. It should be noted that if $|i - j|$ becomes large,

$$a^{|i - j|} \to 0 \text{ and } b^{|i - j|} \to 0$$

and the correlation damps out.

The correlation coefficient in range is a, and b is in deflection. These values can be input into the program if they are known. If the correlation coefficients are not known for the particular gun system being analyzed, the program will calculate them based on the following equations:

$$a = e^{-1.5T - 3T^2}$$

and

$$b = e^{-0.25T^{.4} - 5.35T^2}$$

where T is time in seconds between rounds.

In the computation of the target kill probabilities, each iteration of the Monte Carlo process represents one pass at the target. The attacking aircraft commences firing at the start of every pass and continues until one of the following occurs: (1) a killing hit has been scored, (2) the gun jams, or (3) N rounds have been fired. When a gun jams, the number of guns in the system is reduced by one. Therefore,

there is a corresponding reduction in rate of fire. If a jam occurs, the firing loop is exited and a miss is recorded for calculation purposes. Each round has a conditional kill probability (P_{HK}). This is the probability that a hit kills and it has the same value for every round in the burst if only one conditional kill value is input. A conditional kill value can be input for the beginning of the firing run and one at the end. If this option is elected, the program will do a linear interpolation between the beginning and end conditional kill values for each round based on time into the burst. The program computes an aimpoint and a point of impact for each round and assesses damage by testing to see whether the round hit the target and if so whether the hit resulted in a kill. The final probability of kill is set equal to the number of successful passes divided by the total number of passes.

SECTION III

MATHEMATICAL PROCEDURES

The final solution is obtained as shown in the flow chart and the following mathematical procedures. Before starting the first iteration for the first data set dummy passes are made through the random number generator.

For each Monte Carlo iteration there is given the standard deviation of the aim error (σ_R, σ_D) and the aimpoint of the (n - 1)st round. There are also two Gaussian-distributed (mean = 0, standard deviation = 1) random numbers (α, γ) selected, and the aimpoint of the n^{th} round (R_n, D_n) is determined by the following relations:

for the first round (n = 1), then

$$R_1 = \sigma_R \alpha_1 \tag{1}$$

$$D_1 = \sigma_D \gamma_1 \tag{2}$$

$$R_n = aR_{n-1} + \sigma_R (1-a^2)^{1/2} \alpha_n, \; n \neq 1 \tag{3}$$

$$D_n = bD_{n-1} + \sigma_D (1-b^2)^{1/2} \gamma_n, \; n \neq 1 \tag{4}$$

where a and b are the correlation coefficients in range and deflection and R_n and D_n are the respective range and deflection aimpoints for the n^{th} round.

Equation (3) may be rewritten so that

$$R_n = \sigma_R \left[a^{n-1}\alpha_1 + (1-a^2)^{1/2} \sum_{i=2}^{n} a^{n-1}\alpha_i \right] \tag{5}$$

and Equation (4) may be rewritten as

$$D_n = \sigma_D \left[b^{n-1}\beta_1 + (1-b^2)^{1/2} \sum_{i=2}^{n} b^{n-1}\beta_i \right] \tag{6}$$

Then it can be seen from Equations (5) and (6) that

$$E(R_n) = E(D_n) = 0 \tag{7}$$

$$E(R_n^2) = \sigma_R^2 \tag{8}$$

$$E(D_n^2) = \sigma_D^2 \tag{9}$$

$$E(R_n R_m) = \sigma_R^2 a^{|m-n|} \tag{10}$$

$$E(D_n D_m) = \sigma_D^2 b^{|m-n|} \tag{11}$$

Therefore we have a process where each aimpoint is normally distributed with mean zero and standard deviation σ_R, σ_D. We also have a process where the correlation coefficient between the n^{th} and the m^{th} round is $a^{|n-m|}$ in the range direction and $b^{|n-m|}$ in deflection. When a and b equal zero or one the process degenerates into the independent or salvo cases, respectively.

Next, the target size must be considered. The target dimension (ℓ, ω) is given with the firing rate (R), the aircraft speed (C), and the initial slant range (S). From these the half-target size (in mils) is determined for the instant at which the n^{th} round is fired using relations:

$$1/2\ell_n = \frac{500\ell}{S - (n-1)c(\frac{60}{R})\ (1.688)} \tag{12}$$

$$1/2\omega_n = \frac{500\omega}{S - (n-1)c(\frac{60}{R})\ (1.688)} \tag{13}$$

The aimpoint for the n^{th} round is then checked to determine if it is within three standard deviations of the ballistic dispersion (β_R, β_D) measured from the target center, or stated mathematically,

$$|R_n| \leq 1/2\ell_n + 3\beta_R \tag{14}$$

$$|D_n| \leq 1/2\omega_n + 3\beta_D \tag{15}$$

If the aimpoint is not within three standard deviations of the ballistic dispersion from the target in either coordinate, it is assumed that the round missed the target and the aimpoint for the (n + 1)st round is then computed. If the aimpoint is within three standard deviations from the target in both coordinates, a Gaussian-distributed random number (δ) is determined and checked to ascertain whether the round falls within the limits of the target in the range coordinates.

$$|R_n + \beta_R| < 1/2\ell_n \tag{16}$$

If the round does not fall within the target limits a miss is assumed, and the aimpoint for the (n + 1)st round is computed. However, if the n^{th} round does fall within the target limits in the range coordinates another Gaussian-distributed random number (E) is selected and the impact point of the round in the deflection coordinate is determined. The following check is then made to see if the round hit the target.

$$|D_n + \beta_D E| < 1/2\omega_n \tag{17}$$

If the round does not hit the target, the aimpoint for the (n + 1)st round is determined. But, if the n^{th} round does hit the target, a uniformly distributed (between 0 and 1) random number (PP) is selected and compared with the conditional kill probability to determine if the hit results in a target kill. If $P_{HK} < PP$, the weapon does not destroy the target and the aimpoint for the (n + 1)st round is determined. But if $P_{HK} \geq PP$, the n^{th} weapon does kill the target. The count (N_h) of the Monte Carlo iterations for which the target is destroyed is increased by one. Also, a counter (JJ_i) for the next highest multiple (i) of the increment (ΔN) in the number of rounds for which the probability is to be determined is increased by one.

$$N_h + 1 \rightarrow N_h \ , \ JJ_i + 1 \rightarrow JJ_i$$

When a round has resulted in a kill or when the maximum number of rounds (N) has been fired without killing the target, the entire process is repeated until (F) Monte Carlo iterations have been completed.

Finally, the estimated probability of destroying the target with N rounds is determined by:

$$P(N) = \frac{Nh}{F} \tag{18}$$

The probability of destroying the target with j rounds is determined by:

$$P(j) = \sum_{i=1}^{n} \left[\frac{J J_i}{F} \right] \tag{19}$$

where

$$j = n\Delta N; \; n = \left[1, 2, \ldots \frac{N}{\Delta N} \right]$$

SECTION IV

PROGRAM UTILIZATION GUIDE

The utilization guide for the air-to-surface gun simulation computer program is contained in this section. The program variables used are discussed with input formats, limits, and units specified for each.

Throughout the utilization discussion, variables which begin with the letters I, J, K, L, M, N are integer values and are right adjusted in their specified fields with no decimal punched unless otherwise specified. The alphanumeric formats are designated in the description column of the program set-up procedure. All other variables are in decimal or real mode and may be punched anywhere in their columnar field with a decimal point.

This program has three different set-up procedures of which two will accomplish the same end result. The third set-up is a plot option only.

The first set-up is a regular run with any number of cases desired, and limited only by computer time. The second set-up shows the procedure for generating the input data when large parametric runs are needed. The third set-up describes the inputs for the plot only portion of the programs and should not be confused with the first two set-ups which also produce plots as desired.

Figure 3 is a flow chart overview of the gun simulation program with notes.

The regular computer set-up is very simple and straightforward but the generate-the-input set-up can be very ambiguous and frustrating. When the second option can be used it should yield a 10 to 1 savings in set-up time. The analyst should become familiar with this option in order to better utilize his time on large parametric computer runs and data requirement deadlines. It is hoped that the following flow chart will further simplify the generate-the-input set-up.

TIMING

The program run time is based on a number of variables in the program. It is not possible to figure the exact time required for each run. When the analyst becomes familiar with the program it will be easier to estimate the required run time based on the following equation:

RUN TIME = MCI * N * (NO. OF CASES) * .000159

where MCI is the number of Monte Carlo iterations

N is number of rounds fired on each burst.

After calculating the estimated run time for a given set-up it is recommended that more time be added to the job card if the run time is not a limiting factor on the computer system.

INPUT/OUTPUT

Input and output are discussed in detail in Sections V, VI, and VII.

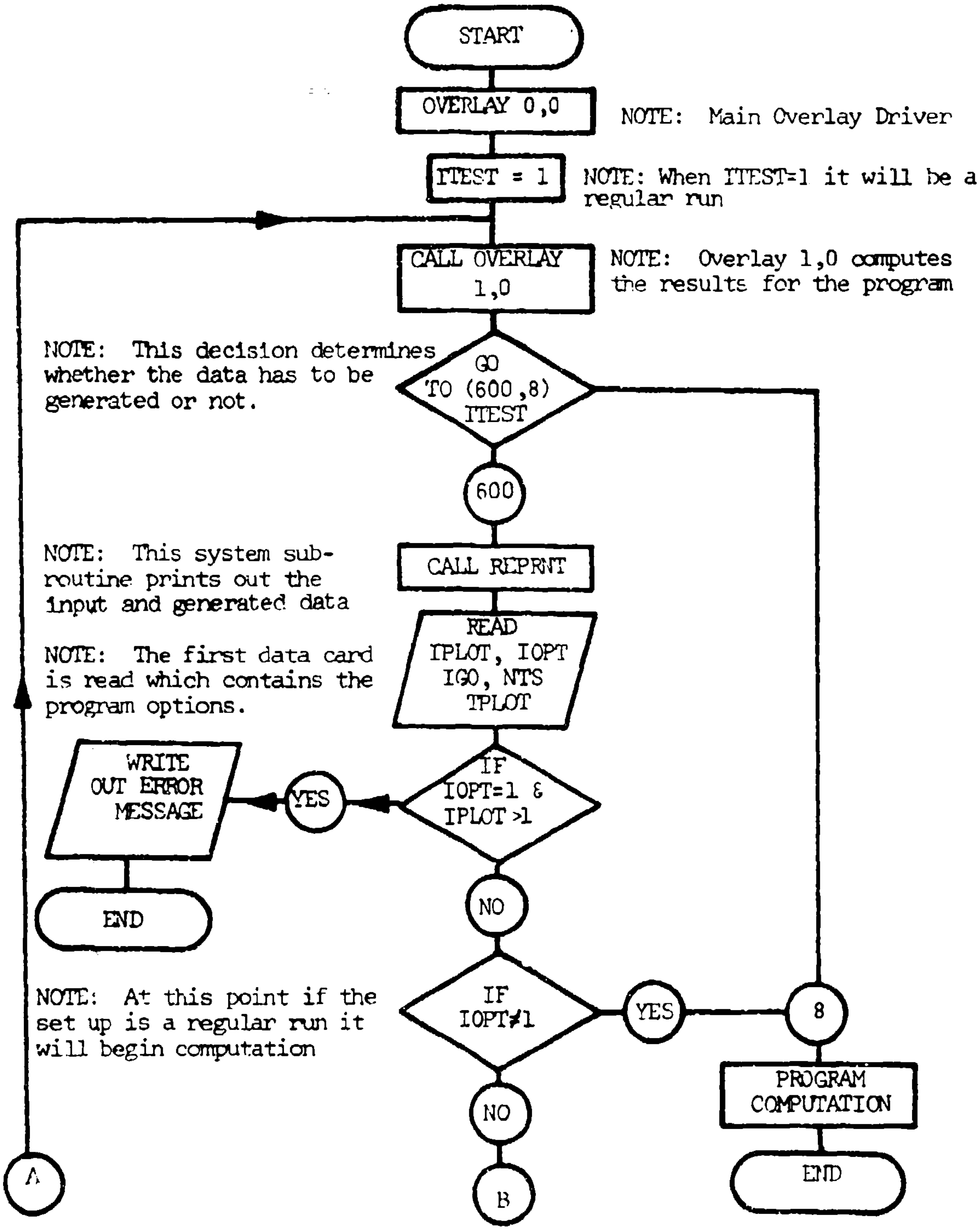

Figure 3. Overview Flow Chart for Gun Simulation Program

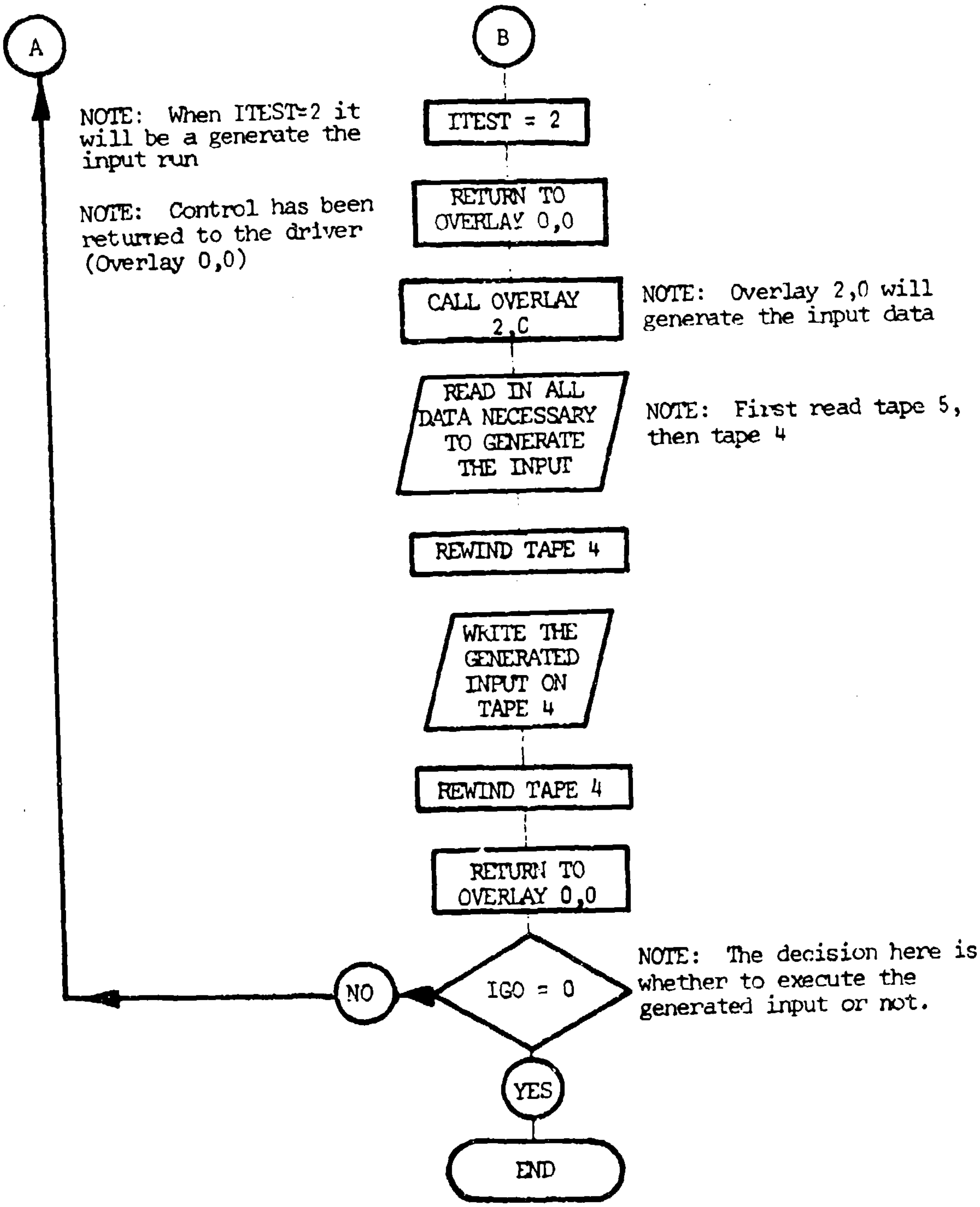

Figure 3. Overview Flow Chart for Gun Simulation Program (Concluded)

SECTION V

REGULAR COMPUTER RUN

SAMPLE PROBLEM

The effectiveness of a strafing tactic for a 150-knot aircraft with a firing rate of 4100 rounds per minute is to be analyzed. The pilot commences firing at a slant range of 1000 feet and fires a single burst of 120 rounds at an 11.74 x 11.74-foot target. The standard deviations of aiming error are 4.24 mils in range and deflection, and the standard deviations of ballistic dispersion are 1.39 mils in range and deflection. The probability of kill given a hit for the first case is a three-round mix with the ammunition belt having four rounds with a PHK of 0.012, 0.016, and two rounds with 0.020, 0.024 and one round with 0.006, 0.010. There are two probability of kill values in each case. The first value is the probability of kill given a hit for the beginning of the burst, and the second value is for the end of the burst. The computer does a linear interpolation between these two values based on time into the burst.

Table 1 contains the description for setting up any regular computer run. Table 2 is a sample set-up of the case described above. Table 3 is an output listing of the input data. Table 4 contains the final output probability of kill for only two of the cases. The first case was at 1000 feet slant range and 150 knots. The second case shown in Table 4 was for 1000 feet slant range and 350 knots air speed. The second case has been included to show the analyst what happens when the conditions become unrealistic. This feature saves paper and computer time. Figure 4 contains the probability of kill for the first six slant ranges. Card 2 in Table 1 indicates the number of cases plotted on one graph.

The required time to run any given set-up is described in Section IV.

TABLE 1. DESCRIPTION OF THE SET-UP FOR A REGULAR COMPUTER RUN

Card	Columns	Variable	Limits	Description	Units
		DESCRIPTION OF THE SET-UP FOR A REGULAR COMPUTER RUN			
1	1	IPLOT	0,1,2	0 = No plots 1 = Plot option has been turned on 2 = Stand alone plot (see PLOT ONLY SET-UP)	
	2	IOPT	0,1	0 = Regular computer run, leave IGO blank 1 = Data will be generated (see GENERATE THE INPUT SET-UP)	
	3	IGO	0,1	0 = Do not execute the generated input data 1 = Execute the generated input data (see GENERATE THE INPUT DATA SET-UP)	
	4-5	NTS	1-10	Number of burst lengths to be plotted	
	6-12 13-19	IPLOT(1) IPLOT(2)		Time which burst length should be plotted	decimal
	69-75	IPLOT(10)		Tenth burst length time	decimal
	NOTE: Card 1 is necessary in the set-up even when all the options are zero.				
2	1-5	NSLANT	1-6	If IPLOT = 1, you must input the number of slant ranges to be plotted on one graph. <u>If no plots are wanted, this card must be omitted from the set-up</u>.	
3	1-60	TITLE		Title or general information (alpha-numeric data)	
	61-70	DIVE	≤90	Dive angle - for identification only	DEG
4	1-2	D(1)	1	Address = 1	
	3-10	A	≥0, ≤1	Correlation coefficient in range between consecutive aimpoints.	

NOTE: A value for the correlation coefficient is computed in the program for each round. This parameter should be set to zero if JIM = 1 on card 24.

TABLE 1. DESCRIPTION OF THE SET-UP FOR A REGULAR COMPUTER RUN (CONTINUED)

Card	Columns	Variable	Limits	Description	Units
10	1-2	D(7)	7	Address = 7	
	3-10	S		Slant range at the beginning of firing run.	feet
	1-2	D(8)	8	Address = 8	
	3-10	R		Firing rate of gun in rounds per minute.	RPM
12	1-2	D(9)	9	Address = 9	
	3-10	C		Aircraft speed	knots
13	1-2	D(10)	10	Address = 10	
	3-10	N		Number of rounds fired on a single pass per gun.	decimal
14	1-2	D(11)	11	Address = 11	
	3-10	NTYPE	1,2,3	Number of types of mixed belts. Set equal to 1 if no mixed belts.	
15	1-5	NUMR(I)	Blank-N	Number of consecutive rounds using this conditional kill probability. If left blank the program sets NUMR(I) equal to N.	
	6-15	CP1(I)		Starting value for the conditional kill probability - if CPN is left blank, CP1(I) is used for all rounds.	
	16-25	CPN(I)		End value for the conditional kill probability. If an end value is used, the program does a linear interpolation between CP1 and CPN based on time.	
	NOTE: Repeat card 15 NTYPE times.				
16	1-2	D(12)	12	Address = 12	
	3-10	L		Target length	feet decimal
17	1-2	D(13)	13	Address = 13	
	3-10	W		Target width	feet

TABLE 1. DESCRIPTION OF THE SET-UP FOR A REGULAR COMPUTER RUN (CONTINUED)

Card	Columns	Variable	Limits	Description	Units
18	1-2	D(14)	14	Address = 14	
	3-10	F	200-∞	Maximum number of Monte Carlo iterations.	
19	1-2	D(15)	15	Address = 15	
	3-10	II		Number of dummy passes through random number generator.	decimal
20	1-2	D(16)		Address = 16	
	3-10	DN	≤N	Increment in burst length.	
				NOTE: This controls the number of lines that will be printed; i.e., 1 will cause the printer to write out a data line for each round in the burst.	
21	1-2	D(17)	17	Address = 17	
	3-10	E		Desired maximum value of the standard deviation of the mean.	
22	1-2	D(18)	18	Address = 18	
	3-10	PJAM		Probability of the gun jamming.	
23	1-2	D(19)	19	Address = 19	
	3-10	GUNS		Number of gun systems to be analyzed.	
				NOTE: The program computes a final probability of kill based on the total number of gun systems.	
24	1-2	D(20)	20	Address = 20	
	3-10	JIM	0,1	0 = indicates that you have input some correlation value in cards 4 and 5 other than zero and omit cards 25, 26 and 27. 1 = indicates you have a zero in cards 4 and 5 and plan to input a time-to-rate table for a Gatling gun by completing cards 25, 26 and 27.	decimal
25	1-5	NOT	≤30	Number of pairs of entries for the time-to-rate table for a Gatling gun.	

TABLE 1. DESCRIPTION OF THE SET-UP FOR A REGULAR COMPUTER RUN (CONCLUDED)

Card	Columns	Variable	Limits	Description	Units
26	1-8	RD(1)		Number of rounds fired at TIME (1)	
	9-16	RD(2)		Number of rounds fired at TIME (2)	
	.	.		.	
	.	.		.	
	.	.		.	
	3 cards	RD(NOT)		Number of rounds fired at TIME (NOT)	
	NOTE: If JIM = 1 you can have 1≤ cards ≤3, typical for card 27 also.				
27	1-5	TIME(1)		Time to fire RD(1) rounds	
	6-10	TIME(2)		Time to fire RD(2) rounds	
	.	.		.	
	.	.		.	
	.	.		.	
	3 cards	TIME(NOT)		Time to fire RD(NOT) rounds	
28				BLANK CARD AT END OF EACH DATA SET	

NOTE: For multiple cases, include the title (card 4) and any parameters that may change from card 4 to 28. Cases are unlimited. If the time to rate table (cards 25, 26, 27) is changed, the conditional kill probability (cards 14, 15) must also be repeated.

TABLE 2. SAMPLE SET-UP FOR 'REGULAR COMPUTER RUN'

Line	1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
1	10.8	.5 1.0	1.5	2.0				
2	6							
3	SAMPLE * REGULAR COMPUTER RUN *							
4	1 1.0							
5	2 0.0							
6	3 4.24							
7	4 4.24							
8	5 1.39							
9	6 1.39							
10	7 1000.0							
11	8 4100.0							
12	9 150.0							
13	10 120							
14	11 3							
15	4	.012	.016					
16	2	.020	.024					
17	1	.006	.010					
18	12 11.74							
19	13 11.74							
20	14 500.0							

TABLE 2. SAMPLE SET-UP FOR 'REGULAR COMPUTER RUN' (Continued)

Card	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
1	15 10.0							
2	16 1.0							
3	17 .001							
4	18 .001							
5	19 1.0							
6	20 1.0							
7	4							
8	0.0	1.0	51.0	180.0				
9	0.0 18	1.0 2.0						
10	—— BLANK CARD ——							
11	TITLE - 2000 FT SLANT RANGE							
12	7 2000.0							
13	11 3							
14	4	.011	.015					
15	2	.019	.023					
16	1	.005	.009					
17	—— BLANK CARD ——							
18	TITLE - 3000 FT SLANT RANGE							
19	7 3000.0							
20	11 3							

TABLE 2. SAMPLE SET-UP FOR 'REGULAR COMPUTER RUN' (Continued)

	1 10	11 20	21 30	31 40	41 50	51 60	61 70	71 80
1	4	.008	.012					
2	2	.016	.020					
3	1	.004	.008					
4	BLANK CARD							
5	TITLE - 4000 FT SLANT RANGE							
6	7 4000.0							
7	11 3							
8	4	.006	.010					
9	2	.014	.018					
10	1	.003	.007					
11	BLANK CARD							
12	TITLE - 5000 FT SLANT RANGE							
13	7 5000.0							
14	11 3							
15	4	.004	.008					
16	2	.012	.016					
17	1	.002	.006					
18	BLANK CARD							
19	6							
20	TITLE - 6000 FT SLANT RANGE							

TABLE 2. SAMPLE SET-UP FOR 'REGULAR COMPUTER RUN' (Concluded)

	1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
1	7 6000.0							
2	11 3							
3	4	.003	.007					
4	2	.011	.015					
5	1	.001	.005					
6	BLANK CARD							
7	TITLE - 1000 FT SLANT							
8	7 1000.0							
9	9 250.0							
10	11 3							
11	4	.014	.018					
12	2	.022	.026					
13	1	.008	.012					
14	BLANK CARD							
15	TITLE - ECT.							
16	CONTINUE WITH MORE CASES							
17								
18								
19								
20								

TABLE 3. REPRNT LISTING OF INPUT DATA FOR A REGULAR COMPUTER RUN

```
INPUT DATA ---------
CARD NO.  1        10             20             30             40             50             60             70

  1       10  4       .5      1.0      1.5      2.0
  2            6
  3             SAMPLE * REGULAR COMPUTER RUN *                                                        15
  4        1       0.0
  5        2       0.0
  6        3       4.24
  7        4       4.24
  8        5       1.39
  9        6       1.39
 10        7    1000.0
 11        8    4180.0
 12        9     150.0
 13       10     120.0
 14       11         3
 15            4         .012          .016
 16            2         .020          .024
 17            1         .006          .010
 18       12      11.74
 19       13      11.74
 20       14     500.0
 21       15      10.0
 22       16       1.0
 23       17      .001
 24       18      .001
 25       19       1.0
 26       20       1.0
 27            4
 28              0.0      1.0      51.0     120.0
 29         0.0   .16   1.0   2.0
 30
 31       TITLE - 2000 FT SLANT RANGE
 32        7   2000.0
 33       11         3
 34            4         .011          .015
 35            2         .019          .023
 36            1         .005          .009
 37
 38       TITLE - 3000 FT SLANT RANGE
 39        7   3000.0
 40       11         3
 41            4         .008          .012
 42            2         .016          .020
 43            1         .004          .008
 44
 45       TITLE - 4000 FT SLANT RANGE
 46        7   4000.0
 47       11         3
 48            4         .036          .010
 49            2         .014          .018
 50            1         .003          .007
 51
 52       TITLE - 5000 FT SLANT RANGE
 53        7   5000.0
 54       11         3
 55            4         .004          .008
 56            2         .012          .016
 57            1         .002          .006
 58
 59       TITLE - 6000 FT SLANT RANGE
 60        7   6000.0
 61       11         3
 62            4         .003          .007
 63            2         .011          .015
 64            1         .001          .005
 65
 66            6
 67       TITLE - 1000 FT SLANT RANGE
 68        7   1000.0
 69        9    250.0
 70       11         3
 71            4         .014          .018
```

TABLE 3. REPRINT LISTING OF INPUT DATA FOR A REGULAR COMPUTER RUN (CONTINUED)

```
INPUT DATA --------
CARD NO.    1        10        20        30        40        50        60        70

   72           2       .022      .026
   73           1       .008      .012
   74
   75       TITLE - 2000 FT SLANT RANGE
   76        7  2000.0
   77       11        3
   78           4       .013      .017
   79           2       .021      .025
   80           1       .007      .011
   81
   82       TITLE - 3000 FT SLANT RANGE
   83        7  3000.0
   84       11        3
   85           4       .010      .014
   86           2       .018      .022
   87           1       .006      .010
   88
   89       TITLE - 4000 FT SLANT RANGE
   90        7  4000.0
   91       11        3
   92           4       .008      .012
   93           2       .016      .020
   94           1       .005      .009
   95
   96       TITLE - 5000 FT SLANT RANGE
   97        7  5000.0
   98       11        3
   99           4       .006      .010
  100           2       .014      .018
  101           1       .004      .008
  102
  103       TITLE - 6000 FT SLANT RANGE
  104        7  6000.0
  105       11        3
  106           4       .005      .009
  107           2       .013      .017
  108           1       .003      .007
  109
  110           6
  111       TITLE - 1000 FT SLANT RANGE
  112        7  1000.0
  113        9   350.0
  114       11        3
  115           4       .016      .020
  116           2       .024      .028
  117           1       .010      .014
  118
  119       TITLE - 2000 FT SLANT RANGE
  120        7  2000.0
  121       11        3
  122           4       .015      .019
  123           2       .023      .027
  124           1       .009      .013
  125
  126       TITLE - 3000 FT SLANT RANGE
  127        7  3000.0
  128       11        3
  129           4       .012      .016
  130           2       .020      .024
  131           1       .008      .012
  132
  133       TITLE - 4000 FT SLANT RANGE
  134        7  4000.0
  135       11        3
  136           4       .010      .014
  137           2       .018      .022
  138           1       .007      .011
  139
  140       TITLE - 5000 FT SLANT RANGE
  141        7  5000.0
  142       11        3
```

TABLE 3. REPRNT LISTING OF INPUT DATA FOR A REGULAR COMPUTER RUN (CONCLUDED)

```
INPUT DATA --------
CARD NO.   1        10        20        30        40        50        60        70

  143          4      .008      .012
  144          2      .016      .020
  145          1      .006      .010
  146
  147      TITLE - 6000 FT SLANT RANGE
  148        7   6000.0
  149      11        3
  150          4      .007      .011
  151          2      .015      .019
  152          1      .005      .009
  153
  154          6
  155      TITLE - 1000 FT SLANT RANGE
  156        7   1000.0
  157        9    450.0
  158      11        3
  159          4      .018      .022
  160          2      .026      .030
  161          1      .012      .016
  162
  163      TITLE - 2000 FT SLANT RANGE
  164        7   2000.0
  165      11        3
  166          4      .017      .021
  167          2      .025      .029
  168          1      .011      .015
  169
  170      TITLE - 3000 FT SLANT RANGE
  171        7   3000.0
  172      11        3
  173          4      .014      .018
  174          2      .022      .026
  175          1      .010      .014
  176
  177      TITLE - 4000 FT SLANT RANGE
  178        7   4000.0
  179      11        3
  180          4      .012      .016
  181          2      .020      .024
  182          1      .009      .013
  183
  184      TITLE - 5000 FT SLANT RANGE
  185        7   5000.0
  186      11        3
  187          4      .010      .014
  188          2      .018      .022
  189          1      .008      .012
  190
  191      TITLE - 6000 FT SLANT RANGE
  192        7   6000.0
  193      11        3
  194          4      .009      .013
  195          2      .017      .021
  196          1      .007      .011
  197
```

TABLE 4. OUTPUT

SAMPLE * REGULAR COMPUTER RUN *

COORDINATE	AIM ERROR (MILS)	BALLISTIC DISPERSION (MILS)
RANGE	4.2	1.4
DEFLECTION	4.2	1.4

AIRCRAFT SPEED (KTAS) = 150.
STEADY STATE FIRING RATE PER GUN (RDS/MIN) = 4100.
SLANT RANGE AT COMMENCEMENT OF FIRING RUN (FT) = 1000.
NO. OF ROUNDS PER PASS PER GUN = 120
PROBABILITY OF JAMMING = .00100

TARGET LENGTH (FEET) = 11.7
TARGET WIDTH (FEET) = 11.7

NUMBER OF MONTE CARLO ITERATIONS = 500
NUMBER OF EMPTY PASSES THROUGH RANDOM NO. GENERATORS = 10
NUMBER OF GUN SYSTEMS CONSIDERED = 1

PROBABILITY OF TARGET KILL = .786
STANDARD DEVIATION OF THE MEAN = .0183

NO. OF RDS/GUN	CONDITIONAL KILL PROBABILITY	TIME	CORRELATION CONSTANTS RANGE	CORRELATION CONSTANTS DEFL	SLANT RANGE	KILL PROBABILITY
1	.012	.1800	0.000	0.000	954.	.008
2	.012	.1964	.975	.951	950.	.012
3	.012	.2128	.975	.951	946.	.016
4	.012	.2292	.975	.951	942.	.022
5	.020	.2456	.975	.951	938.	.034
6	.021	.2620	.975	.951	934.	.042
7	.037	.2784	.975	.951	930.	.044
8	.013	.2948	.975	.951	925.	.064
9	.013	.3112	.975	.951	921.	.070
10	.013	.3276	.975	.951	917.	.074
11	.013	.3440	.975	.951	913.	.082
12	.021	.3604	.975	.951	909.	.096
13	.021	.3768	.975	.951	905.	.114
14	.007	.3932	.975	.951	900.	.116
15	.013	.4096	.975	.951	896.	.118
16	.013	.4260	.975	.951	892.	.134
17	.013	.4424	.975	.951	888.	.136
18	.013	.4588	.975	.951	884.	.142
19	.021	.4752	.975	.951	880.	.156
20	.021	.4916	.975	.951	876.	.178
21	.007	.5080	.975	.951	871.	.184
22	.013	.5244	.975	.951	867.	.198
23	.013	.5408	.975	.951	863.	.212
24	.013	.5572	.975	.951	859.	.218
25	.013	.5736	.975	.951	855.	.226
26	.021	.5900	.975	.951	851.	.230
27	.021	.6064	.975	.951	846.	.248
28	.007	.6228	.975	.951	842.	.252
29	.013	.6392	.975	.951	838.	.260
30	.013	.6556	.975	.951	834.	.270
31	.013	.6720	.975	.951	830.	.278
32	.013	.6884	.975	.951	826.	.290
33	.021	.7048	.975	.951	822.	.296
34	.021	.7212	.975	.951	817.	.310
35	.007	.7376	.975	.951	813.	.314
36	.014	.7540	.975	.951	809.	.324
37	.014	.7704	.975	.951	805.	.334
38	.014	.7868	.975	.951	801.	.342
39	.014	.8032	.975	.951	797.	.350
40	.022	.8196	.975	.951	792.	.362
41	.022	.8360	.975	.951	788.	.374
42	.008	.8524	.975	.951	784.	.376
43	.014	.8688	.975	.951	780.	.382
44	.014	.8852	.975	.951	776.	.384
45	.014	.9016	.975	.951	772.	.388
46	.014	.9180	.975	.951	768.	.394
47	.022	.9344	.975	.951	763.	.400
48	.022	.9508	.975	.951	759.	.420
49	.008	.9672	.975	.951	755.	.422
50	.014	.9836	.975	.951	751.	.422
51	.014	1.0000	.975	.951	747.	.430
52	.014	1.0145	.978	.954	743.	.432
53	.014	1.0290	.978	.954	739.	.442

TABLE 4. OUTPUT (CONTINUED)

NO. OF RDS/GUN	CONDITIONAL KILL PROBABILITY	TIME	CORRELATION CONSTANTS RANGE	DEFL	SLANT RANGE	KILL PROBABILITY
54	.022	1.0435	.978	.954	736.	.448
55	.022	1.0580	.978	.954	732.	.458
56	.008	1.0725	.978	.954	728.	.462
57	.014	1.0870	.978	.954	725.	.464
58	.014	1.1014	.978	.954	721.	.472
59	.014	1.1159	.978	.954	717.	.476
60	.014	1.1304	.978	.954	714.	.478
61	.022	1.1449	.978	.954	710.	.486
62	.022	1.1594	.978	.954	706.	.502
63	.008	1.1739	.978	.954	703.	.504
64	.014	1.1884	.978	.954	699.	.506
65	.014	1.2029	.978	.954	695.	.518
66	.014	1.2174	.978	.954	692.	.524
67	.014	1.2319	.978	.954	688.	.532
68	.022	1.2464	.978	.954	684.	.538
69	.023	1.2609	.978	.954	681.	.550
70	.009	1.2754	.978	.954	677.	.554
71	.015	1.2899	.978	.954	673.	.556
72	.015	1.3043	.978	.954	670.	.566
73	.015	1.3188	.978	.954	666.	.566
74	.015	1.3333	.978	.954	662.	.572
75	.023	1.3478	.978	.954	659.	.580
76	.023	1.3623	.978	.954	655.	.592
77	.009	1.3768	.978	.954	651.	.598
78	.015	1.3913	.978	.954	648.	.598
79	.015	1.4058	.978	.954	644.	.598
80	.015	1.4203	.978	.954	640.	.604
81	.015	1.4348	.978	.954	637.	.612
82	.023	1.4493	.978	.954	633.	.616
83	.023	1.4638	.978	.954	629.	.618
84	.009	1.4783	.978	.954	626.	.618
85	.015	1.4928	.978	.954	622.	.624
86	.015	1.5072	.978	.954	618.	.628
87	.015	1.5217	.978	.954	615.	.634
88	.015	1.5362	.978	.954	611.	.638
89	.023	1.5507	.978	.954	607.	.644
90	.023	1.5652	.978	.954	604.	.650
91	.009	1.5797	.978	.954	600.	.652
92	.015	1.5942	.978	.954	596.	.654
93	.015	1.6087	.978	.954	593.	.658
94	.015	1.6232	.978	.954	589.	.662
95	.015	1.6377	.978	.954	585.	.668
96	.023	1.6522	.978	.954	582.	.684
97	.023	1.6667	.978	.954	578.	.690
98	.009	1.6812	.978	.954	574.	.690
99	.015	1.6957	.978	.954	571.	.692
100	.015	1.7101	.978	.954	567.	.692
101	.015	1.7246	.978	.954	563.	.698
102	.015	1.7391	.978	.954	560.	.702
103	.024	1.7536	.978	.954	556.	.710
104	.024	1.7681	.978	.954	552.	.716
105	.010	1.7826	.978	.954	549.	.716
106	.016	1.7971	.978	.954	545.	.726
107	.016	1.8116	.978	.954	541.	.734
108	.016	1.8261	.978	.954	538.	.738
109	.016	1.8406	.978	.954	534.	.748
110	.024	1.8551	.978	.954	530.	.750
111	.024	1.8696	.978	.954	527.	.754
112	.010	1.8841	.978	.954	523.	.756
113	.016	1.8986	.978	.954	519.	.760
114	.016	1.9130	.978	.954	516.	.766
115	.016	1.9275	.978	.954	512.	.770
116	.016	1.9420	.978	.954	508.	.774
117	.024	1.9565	.978	.954	505.	.778
118	.024	1.9710	.978	.954	501.	.778
119	.010	1.9855	.978	.954	497.	.780
120	.016	2.0000	.978	.954	494.	.786

TABLE 4. OUTPUT (CONTINUED)

TITLE - 1000 FT SLANT RANGE

COORDINATE	AIM ERROR (MILS)	BALLISTIC DISPERSION (MILS)
RANGE	4.2	1.4
DEFLECTION	4.2	1.4

AIRCRAFT SPEED (KTAS) = 350.
STEADY STATE FIRING RATE PER GUN (RDS/MIN) = 4180.
SLANT RANGE AT COMMENCEMENT OF FIRING RUN (FT) = 1000.
NO. OF ROUNDS PER PASS PER GUN = 120
PROBABILITY OF JAMMING = .00100

TARGET LENGTH (FEET) = 11.7
TARGET WIDTH (FEET) = 11.7

NUMBER OF MONTE CARLO ITERATIONS = 200
NUMBER OF EMPTY PASSES THROUGH RANDOM NO. GENERATORS = 10
NUMBER OF GUN SYSTEMS CONSIDERED = 1

PROBABILITY OF TARGET KILL = 1.000
STANDARD DEVIATION OF THE MEAN = 0.0000

NO. OF RDS/GUN	CONDITIONAL KILL PROBABILITY	TIME	CORRELATION CONSTANTS RANGE	CORRELATION CONSTANTS DEFL	SLANT RANGE	KILL PROBABILITY
1	.016	.1800	0.000	0.000	894.	.010
2	.016	.1964	.975	.951	884.	.025
3	.016	.2128	.975	.951	874.	.030
4	.015	.2292	.975	.951	865.	.035
5	.024	.2456	.975	.951	855.	.050
6	.025	.2620	.975	.951	845.	.070
7	.011	.2784	.975	.951	836.	.075
8	.017	.2948	.975	.951	826.	.085
9	.017	.3112	.975	.951	816.	.100
10	.017	.3276	.975	.951	806.	.115
11	.017	.3440	.975	.951	797.	.125
12	.025	.3604	.975	.951	787.	.140
13	.025	.3768	.975	.951	777.	.155
14	.011	.3932	.975	.951	768.	.165
15	.017	.4096	.975	.951	758.	.180
16	.017	.4260	.975	.951	748.	.195
17	.017	.4424	.975	.951	739.	.220
18	.017	.4588	.975	.951	729.	.230
19	.025	.4752	.975	.951	719.	.255
20	.025	.4916	.975	.951	710.	.260
21	.011	.5080	.975	.951	700.	.270
22	.017	.5244	.975	.951	690.	.275
23	.017	.5408	.975	.951	680.	.280
24	.017	.5572	.975	.951	671.	.305
25	.017	.5736	.975	.951	661.	.320
26	.025	.5900	.975	.951	651.	.335
27	.025	.6064	.975	.951	642.	.370
28	.011	.6228	.975	.951	632.	.375
29	.017	.6392	.975	.951	622.	.395
30	.017	.6556	.975	.951	613.	.400
31	.017	.6720	.975	.951	603.	.410
32	.017	.6884	.975	.951	593.	.420
33	.025	.7048	.975	.951	584.	.430
34	.025	.7212	.975	.951	574.	.440
35	.011	.7376	.975	.951	564.	.440
36	.018	.7540	.975	.951	555.	.440
37	.018	.7704	.975	.951	545.	.440
38	.018	.7868	.975	.951	535.	.450
39	.018	.8032	.975	.951	525.	.455
40	.026	.8196	.975	.951	516.	.470
41	.026	.8360	.975	.951	506.	.485
42	.012	.8524	.975	.951	496.	.485
43	.018	.8688	.975	.951	487.	.495
44	.018	.8852	.975	.951	477.	.510
45	.018	.9016	.975	.951	467.	.510
46	.018	.9180	.975	.951	458.	.515
47	.026	.9344	.975	.951	448.	.520
48	.026	.9508	.975	.951	438.	.525
49	.012	.9672	.975	.951	429.	.535
50	.018	.9836	.975	.951	419.	.540
51	.018	1.0000	.975	.951	409.	.545
52	.018	1.0145	.978	.954	401.	.545
53	.018	1.0290	.978	.954	392.	.550

TABLE 4. OUTPUT (CONCLUDED)

NO. OF RDS/GUN	CONDITIONAL KILL PROBABILITY	TIME	CORRELATION CONSTANTS RANGE	CORRELATION CONSTANTS DEFL	SLANT RANGE	KILL PROBABILITY
54	.026	1.0435	.978	.954	394.	.555
55	.026	1.0580	.978	.954	375.	.565
56	.012	1.0725	.978	.954	366.	.575
57	.018	1.0870	.978	.954	358.	.580
58	.018	1.1014	.978	.954	349.	.585
59	.018	1.1159	.978	.954	341.	.590
60	.018	1.1304	.978	.954	332.	.595
61	.026	1.1449	.978	.954	324.	.595
62	.026	1.1594	.978	.954	315.	.605
63	.012	1.1739	.978	.954	306.	.615
64	.018	1.1884	.978	.954	298.	.625
65	.018	1.2029	.978	.954	289.	.635
66	.018	1.2174	.978	.954	281.	.650
67	.018	1.2319	.978	.954	272.	.655
68	.026	1.2464	.978	.954	264.	.660
69	.027	1.2609	.978	.954	255.	.675
70	.013	1.2754	.978	.954	247.	.685
71	.019	1.2899	.978	.954	238.	.695
72	.019	1.3043	.978	.954	229.	.695
73	.019	1.3188	.978	.954	221.	.705
74	.019	1.3333	.978	.954	212.	.715
75	.027	1.3478	.978	.954	204.	.715
76	.027	1.3623	.978	.954	195.	.730
77	.013	1.3768	.978	.954	187.	.735
78	.019	1.3913	.978	.954	178.	.740
79	.019	1.4058	.978	.954	169.	.745
80	.019	1.4203	.978	.954	161.	.760
81	.019	1.4348	.978	.954	152.	.760
82	.027	1.4493	.978	.954	144.	.770
83	.027	1.4638	.978	.954	135.	.780
84	.013	1.4783	.978	.954	127.	.785
85	.019	1.4928	.978	.954	118.	.785
86	.019	1.5072	.978	.954	110.	.795
87	.019	1.5217	.978	.954	101.	.800
88	.019	1.5362	.978	.954	92.	.800
89	.027	1.5507	.978	.954	84.	.810
90	.027	1.5652	.978	.954	75.	.810
91	.013	1.5797	.978	.954	67.	.815
92	.019	1.5942	.978	.954	58.	.815
93	.019	1.6087	.978	.954	50.	.815
94	.019	1.6232	.978	.954	41.	.815
95	.019	1.6377	.978	.954	32.	.815
96	.027	1.6522	.978	.954	24.	.825
97	.027	1.6667	.978	.954	15.	.825
98	.013	1.6812	.978	.954	7.	.825
99	.019	1.6957	.978	.954	-2.	1.000

THE AIRCRAFT FLEW INTO THE TARGET AFTER FIRING 98 ROUNDS

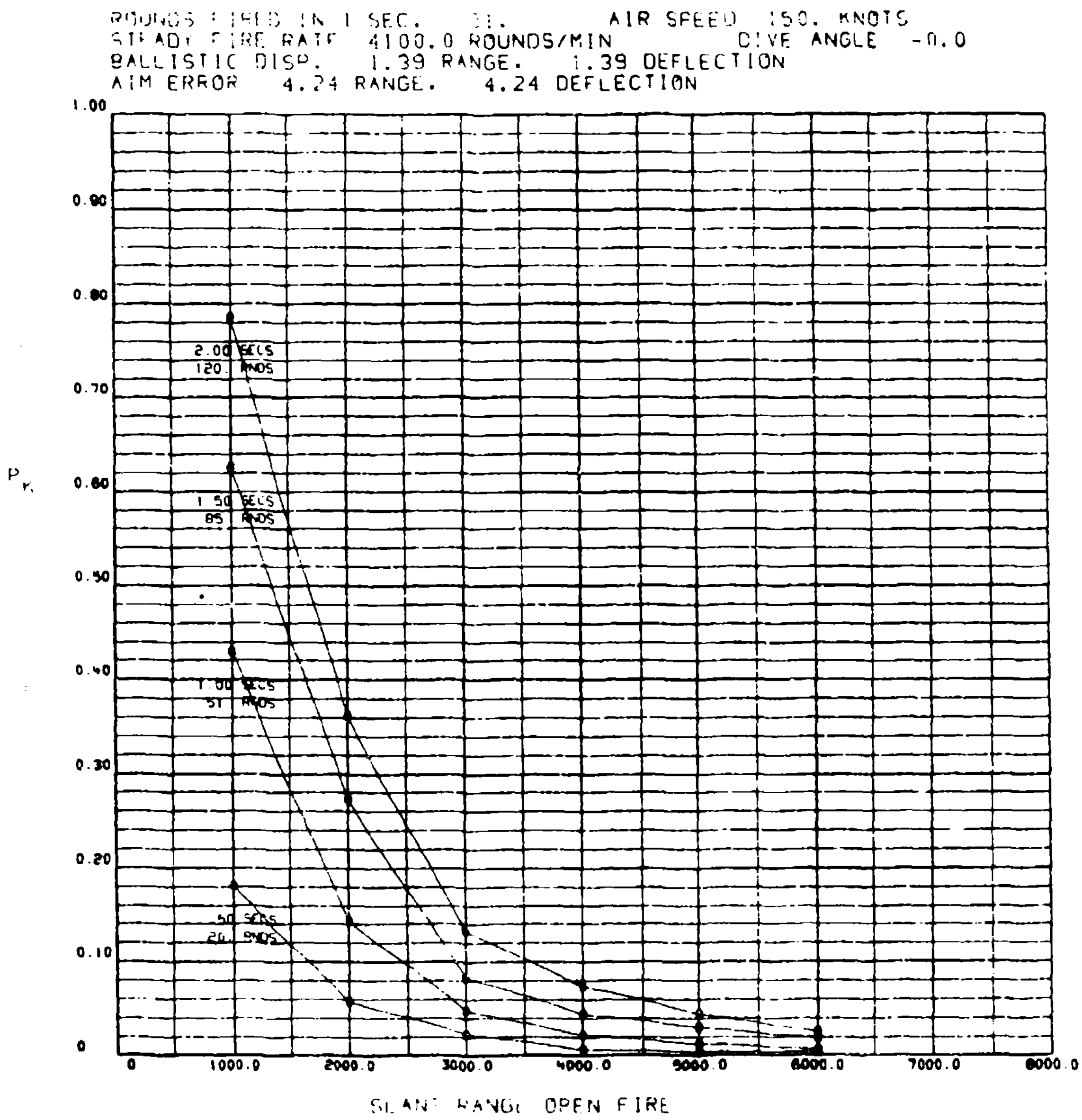

Figure 4. Filmplot Output Sample for Regular Computer Run

SECTION VI

GENERATE THE INPUT RUN

SAMPLE PROBLEM

The sample for Generate the Input Run uses the same data as the Regular Computer Run in order to demonstrate the flexibility, time savings and less chance for errors that can be realized through the use of this technique (see sample problem in Section V for details of problem).

There are five parameters that change more frequently than the other inputs. They are listed in Figure 5 with their hierarchy. Table 5 describes how to set the job up. Table 6 is a sample coding for the problem. Table 7 is a REPRNT listing (a computer system routine) of the input data. Table 8 contains a list of the data generated from the input from Table 7. The final output listing is given in Table 9 with most of the input values included. After the columnar titles each round is analyzed for the entire burst. This output is the same as the Regular Computer Run. Also when the slant range goes negative the computation stops and prints out a message that the aircraft flew into the target. Figure 6 is the filmplot output for the first six slant range values with their respective probability of kill values plotted.

The time required for any given computer run can be calculated by the equation described in Section IV.

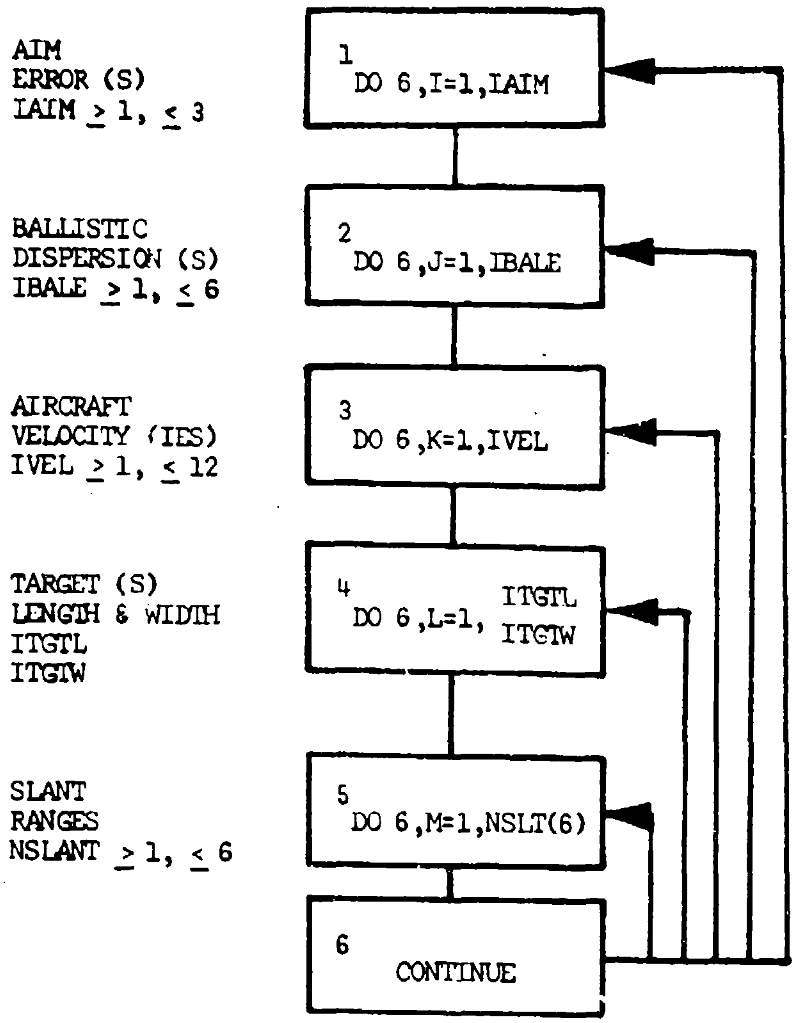

Figure 5. Flow Chart for Generate the Input Run

TABLE 5. DESCRIPTION OF THE SET-UP FOR A GENERATE THE INPUT RUN

Card	Columns	Variable	Limits	Description	Units
1	1	IPLOT	0,1,2	0 = No plots. 1 = Plot option has been turned on. 2 = Stand alone plot.	
	2	[illegible]	0,1	0 = Regular computer run. 1 = Data will be generated.	
	3	IG.	0,1	0 = Do not execute the generated input data. This is used for checking the set-up before executing it. 1 = Execute the generated input data.	
	4-5	[illegible]	1-10	Number of burst lengths to be plotted.	
	6-12 13-19 . . . 69-75	IPLOT(1) IPLOT(2) . . . IPLOT(10)		Time which burst length should be plotted. [illegible]	secs decimal
2	1-2	D(1)	1	Address = 1.	
	3-10	A	≥0,≤1	Correlation coefficient in range between consecutive aimpoints.	

NOTE: If a value for the correlation coefficient is computed in the program for each round, this parameter should be set to zero if JEM = 1 on card 12.

Card	Columns	Variable	Limits	Description	Units
3	1-2	D(2)	2	Address = 2.	
	3-10	B	≥0, ≤1	Correlation coefficient in deflection between consecutive aimpoints.	

NOTE: If a value for the correlation coefficient is computed in the program for each round, this parameter should be set to zero if JEM = 1 on card 12.

TABLE 5. DESCRIPTION OF THE SET-UP FOR A GENERATE THE INPUT RUN (CONTINUED)

Card	Columns	Variable	Limits	Description	Units
4	1-2	D(8)	8	Address = 8.	
	3-10	R		Firing rate of gun in rounds per minute.	
5	1-2	D(10)	10	Address = 10.	
	3-10	N		Number of rounds fired on a single pass per gun.	decimal
6	1-2	D(14)	14	Address = 14.	
	3-10	P	200-∞	Maximum number of Monte Carlo iterations.	
7	1-2	D(15)	15	Address = 15.	
	3-10	II		Number of dummy passes through random number generator.	decimal
8	1-2	D(16)	16	Address = 16.	
	3-10	DN	≥1	Increment in burst length.	
	NOTE: This controls the number of lines that will be printed, i.e., 1 will cause the printer to write out a data line for each round in the burst.				
9	1-2	D(17)	17	Address = 17.	
	3-10	E		Desired maximum value of the standard deviation of the mean.	
10	1-2	D(18)	18	Address = 18.	
	3-10	PJAM		Probability of the gun jamming.	
11	1-2	D(19)	19	Address = 19.	
	3-10	GUNS		Number of gun systems to be analyzed.	

NOTE: The program computes a final probability of kill based on the total number of gun systems.

TABLE 5. DESCRIPTION OF THE SET-UP FOR A GENERATE THE INPUT RUN (CONTINUED)

Card	Columns	Variable	Limits	Description	Units
12	1-2	D(20)	20	Address = 20	
	3-10	JIM	0,1	0 indicates that you have input some correlation value in cards 2 and 3 other than zero and omit cards 13, 14, and 15. 1 indicates you have a zero in cards 2 and 3 for the correlation values and plan to input a time-to-rate table for a Gatling gun by completing cards 13, 14, and 15.	
13	1-5	NOT	≤30	Number of pairs of entries for the time-to-rate table for 1 Gatling gun.	
14	1-8	RD(1)		Number of rounds fired at TIME (1)	
	9-16	RD(2)		Number of rounds fired at TIME (2)	
	.	.		.	
	.	.		.	
	.	.		.	
	3 cards	RD(NOT)		Number of rounds fired at TIME (NOT)	
	NOTE: You can have from 1 to 3 cards for a maximum of 30 entries.				
15	1-5	TIME(1)		Time to fire RD(1) rounds	
	6-10	TIME(2)		Time to fire RD(2) rounds	
	.	.		.	
	.	.		.	
	.	.		.	
	3 cards	TIME(NOT)		Time to fire RD(NOT) rounds	
16				Blank card	
17				End of record card	
18	1-2	IAIM	1,2,3	Number of sets of aiming errors	
	6-10	SIGMA (ALPHA)(1)		Beginning value for the first standard deviation of the aim error in range	mils σ
	11-15	SGR1(1)		End value for standard deviation aim error in range	mils σ

NOTE: If no end value is used, the beginning value will be used for the entire burst length. If an end value is used, the program will do a linear interpolation between the beginning and end value for the aim error based on the closing range of the aircraft.

TABLE 5. DESCRIPTION OF THE SET-UP FOR A GENERATE THE INPUT RUN (CONTINUED)

CARD	COLUMNS	VARIABLE	LIMITS	DESCRIPTION	UNITS
	16-20	SIGMA (BETA)(1)		Beginning value for the first standard deviation of the aim error in deflection.	mils σ
	21-25	SGD1(1)		End value for standard deviation aim error in deflection. (See SGR1(1) Note)	mils σ
	26-30	SIGMA (ALPHA)(2)		Beginning value for the second standard deviation of the aim error in range	
	31-35	SGR1(2)		End value for the second standard deviation aim error in range. (See SGR1(1) Note)	
	36-40	SIGMA (BETA)(2)		Beginning value for the second standard deviation aim error in deflection.	
	41-45	SGD1(2)		End value for the second standard deviation aim error in deflection. (See SGR1(1) Note)	
	46-50	SIGMA		Beginning value for the third standard deviation aim error in range	
	51-55	SGR1(3)		End value for the third standard deviation aim error in range. (See SGR1(1) Note)	
	56-60	SIGMA (BETA)(3)		Beginning value for the third standard deviation aim error in deflection.	
	61-65	SGD1(3)		End value for the third standard deviation aim error in deflection. (See SGR1(1) Note)	
19	1-2	IBALE	1-6	Number of sets of ballistic errors	
	6-10	BALE(1)		First ballistic error standard deviation in range	mils σ
	11-15	BALE(2)		First ballistic error standard deviation in deflection. Repeat the above step and this step for a maximum of 6 sets.	mils σ
20	1-2	IVEL	1-12	Number of aircraft velocities following	

TABLE 5. DESCRIPTION OF THE SET-UP FOR A GENERATE THE INPUT RUN (CONTINUED)

Card	Columns	Variable	Limits	Description	Units
	6-10	VEL(1)		First aircraft velocity	knots
	.	.		.	
	.	.		.	
	.	.		.	
	61-65	VEL(12)		Twelfth aircraft velocity	knots
21	1-2	ITGTL	1-12	Number of different target lengths following	
	6-10	TGTL(1)		First target length in range	feet
	.	.			
	.	.			
	.	.			
	61-65	TGTL(12)		Twelfth target length in range	feet
22	1-2	ITGTW	1-12	Number of target widths following	
	6-10	ITGTW(1)		First target width in deflection	feet decimal
	.	.			
	.	.			
	.	.			
	61-65	ITGTW(12)		Twelfth target width in deflection	feet
23	1-2	IKILL	2-6	Number of conditional kill cards in this set - must equal NSLT(1), Card 24	decimal
	NOTE:	This value is used on the first card of each set of conditional kill ratio tables, i.e., when card 23 is repeated second through the sixth time this parameter is omitted. See sample set up.			
	6-10	NTYPE(1)	1,2,3	1,2, or 3 different ammo types analyzed in burst	decimal
	11-15	NUMR(1)		Number of consecutive rounds using the first conditional kill ratio	decimal
	NOTE:	If NUMR(1) = 0 the program sets NUMR(1) equal to N if NTYPE(1) = 1. This card type is the same as card 14 in the REGULAR COMPUTER run set-up.			
	16-20	CBI(1)		Value of the conditional kill ratio at the beginning of the burst	
	21-25	CEI(1)		Value of the conditional kill ratio at the end of the burst. The program does a linear interpolation between the beginning and end values. If no end conditional kill value is input, the beginning value will be used NUMR(1) times.	

TABLE [illegible]. DESCRIPTION OF THE SET-UP FOR A GENERATE THE INPUT RUN (CONCLUDED)

Card	Columns	Variable	Limits	Description	Units
	26-30	NUMR(2)		Number of consecutive rounds using the second conditional kill ratio. This option will be used in NTYPE(1) is 2 or 3.	decimal
	31-35	CP1(2)		Beginning value for second conditional kill ratio in the mixed round ammo belt.	
	36-40	CPN(2)		End value for the second conditional kill ratio in the mixed round ammo belt. When the end value is input, the program does a linear interpolation between the beginning and end values. If no end conditional kill value is input the beginning value will be used NUMR(2) times.	
	41-45	NUMR(3)		Number of consecutive rounds using the third conditional kill ratio. This option will be used if NTYPE(1) is equal to 3.	decimal
	46-50	CP1(3)		Beginning value for the third conditional kill ratio in the mixed round ammo belt.	
	51-55	CPN(3)		End value for the third conditional kill ratio in the mixed round ammo belt. When the end value is input, the program does a linear interpolation between the beginning and end values.	
	NOTE:	Repeat Card 23 NSLT(1) times for each additional set of conditional kill tables (Sets range from 2 to 244). A set is = NSLT(1) or IKILL. No. of sets required = IAIM*IBALE*IVEL*ITGTL.			
24	1-5	ISLRG	1	Number of unique slant range tables; see sample set up.	
	6-10	NSLT(1)	2-6	Number of slant ranges on this card.	
	NOTE:	NSLT(1) should equal IKILL.			
	11-20 . . .	SLRNG(1) . . .		First slant range	feet
	61-70	SLRNG (IKILL)		(IKILL) slant range	feet
25	1-60	TITLE(1)		Hollerith information	
	61-70			Omit this parameter on GENERATE-THE-INPUT data set-up.	

Table 6. SAMPLE SET-UP FOR 'GENERATE THE INPUT'

Line	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
1	111 4	5 1.0	1.5	2.0				
2	1 0.0							
3	2 0.0							
4	8 4100.0							
5	10 120.0							
6	14 1000.0							
7	15 10.0							
8	16 1.0							
9	17 0.001							
10	18 0.001							
11	19 1.0							
12	20 1.0							
13	4							
14	0.0	1.0	51.0	120.0				
15	0.0 18	1.0 2.0						
16	— BLANK CARD —							
17	— END OF RECORD CARD —							
18	1 4.24	4.24						
19	1 1.39	1.39						
20	4 150.0	250.0 350.0	450.0					

Table 6. SAMPLE SET-UP FOR 'GENERATE THE INPUT' (Continued)

	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80
1	1	11.74														
2	1	11.74														
3	6	3.0	4.0	.012	.016	2.0	.020	.024	1.0	.006	.010					
4		3.0	4.0	.011	.015	2.0	.019	.023	1.0	.005	.009					
5		3.0	4.0	.008	.012	2.0	.016	.020	1.0	.004	.008					
6		3.0	4.0	.006	.010	2.0	.014	.018	1.0	.003	.007					
7		3.0	4.0	.004	.008	2.0	.012	.016	1.0	.002	.006					
8		3.0	4.0	.003	.007	2.0	.011	.015	1.0	.001	.005					
9	1	6		1000.0		2000.0		3000.0		4000.0		5000.0		6000.0		
10	SAMPLE - GENERATE THE INPUT															
11	6	3.0	4.0	.014	.018	2.0	.022	.026	1.0	.008	.012					
12		3.0	4.0	.013	.017	2.0	.021	.025	1.0	.007	.011					
13		3.0	4.0	.010	.014	2.0	.018	.022	1.0	.006	.010					
14		3.0	4.0	.008	.012	2.0	.016	.020	1.0	.005	.009					
15		3.0	4.0	.006	.010	2.0	.014	.018	1.0	.004	.008					
16		3.0	4.0	.005	.009	2.0	.013	.017	1.0	.003	.007					
17	6	3.0	4.0	.016	.020	2.0	.024	.028	1.0	.010	.014					
18		3.0	4.0	.015	.019	2.0	.023	.027	1.0	.009	.013					
19		3.0	4.0	.012	.016	2.0	.020	.024	1.0	.008	.012					
20		3.0	4.0	.010	.014	2.0	.018	.022	1.0	.007	.011					

Table 6. SAMPLE SET-UP FOR 'GENERATE THE INPUT' (Concluded)

Card											
1		3.0	4.0	.008	.012	2.0	.016	.020	1.0	.006	.010
2		3.0	4.0	.007	.011	2.0	.015	.019	1.0	.005	.009
3	6	3.0	4.0	.018	.022	2.0	.026	.030	1.0	.012	.016
4		3.0	4.0	.017	.021	2.0	.025	.029	1.0	.011	.015
5		3.0	4.0	.014	.018	2.0	.022	.026	1.0	.010	.014
6		3.0	4.0	.012	.016	2.0	.020	.024	1.0	.009	.013
7		3.0	4.0	.010	.014	2.0	.018	.022	1.0	.008	.012
8		3.0	4.0	.009	.013	2.0	.017	.021	1.0	.007	.011
9	— END OF FILE CARD —										

TABLE 7. REPRNT LISTING OF INPUT DATA FOR THE GENERATE THE INPUT RUN

```
INPUT DATA --------
CARD NO.   1         10        20        30        40        50        60        70

   1      111 4       .5      1.0     1.5     2.0
   2       1       0.0
   3       2       0.0
   4       9    4100.0
   5      10     120.0
   6      14     500.0
   7      15      10.0
   8      16       1.0
   9      17     0.001
  10      18     0.001
  11      19       1.0
  12      20       1.0
  13          4
  14            0.0       1.0      51.0     120.0
  15         0.0 0.18  1.0  2.0
  16

THE FOLLOWING IS A LIST OF PARAMETERS USED TO GENERATE I/P

       IAIM   STANDARD DEVIATION OF AIMING ERROR TABLE
        1       4.24-0.00 4.24-0.00-0.00-0.00-0.00-0.00-0.00-0.00-0.00-0.00

       IBALE  STANDARD DEVIATION OF THE BALLISTIC ERROR TABLE
        1       1.39 1.39-0.00-0.00-0.00-0.00-0.00-0.00-0.00-0.00-0.00

       IVEL   AIRCRAFT SPEED TABLE
        4       150. 250. 350. 450.

       ITGTL  TARGET LENGTH TABLE
        1     11.74

       ITGTW  TARGET WIDTH TABLE
        1     11.74

       IKILL  CONDITIONAL KILL TABLE
        6       3.0   4.0 .012 .0162.000 .020 .0241.000 .006 .010
                3.0   4.0 .011 .0152.000 .019 .0231.000 .005 .009
                3.0   4.0 .008 .0122.000 .016 .0201.000 .004 .008
                3.0   4.0 .006 .0102.000 .014 .0181.000 .003 .007
                3.0   4.0 .004 .0182.000 .012 .0161.000 .002 .006
                3.0   4.0 .003 .0172.000 .011 .0151.000 .001 .005

       ISLRG NSLT    SLANT RANGE TABLE
        1     6      1000.     2000.      3000.      4000.      5000.      6000.

       HOLLERITH INFORMATION -- 1 HOLLERITH CARD PER GROUP OF SLANT RANGES
             SAMPLE  *  GENERATE THE INPUT RUN  *                               -C.

ADDITIONAL I/P GENERATED WITH PREVIOUS TABLES BEING REPLACED BY THESE TABLES

       IKILL  CONDITIONAL KILL TABLE
        6       3.0   4.0 .014 .0182.000 .022 .0261.000 .008 .012
                3.0   4.0 .013 .0172.000 .021 .0251.000 .007 .011
                3.0   4.0 .010 .0142.000 .018 .0221.000 .006 .010
                3.0   4.0 .008 .0122.000 .016 .0201.000 .005 .009
                3.0   4.0 .006 .0122.000 .014 .0181.000 .004 .008
                3.0   4.0 .005 .0192.000 .013 .0171.000 .003 .007

       IKILL  CONDITIONAL KILL TABLE
        6       3.0   4.0 .016 .0232.000 .024 .0281.000 .010 .014
                3.0   4.0 .015 .0192.000 .023 .0271.000 .009 .013
                3.0   4.0 .012 .0162.000 .020 .0241.000 .008 .012
                3.0   4.0 .010 .0142.000 .018 .0221.000 .007 .011
                3.0   4.0 .008 .0122.000 .016 .0201.000 .006 .010
                3.0   4.0 .007 .0112.000 .015 .0191.000 .005 .009

       IKILL  CONDITIONAL KILL TABLE
        6       3.0   4.0 .018 .0222.000 .026 .0301.000 .012 .016
                3.0   4.0 .017 .0212.000 .025 .0291.000 .011 .015
                3.0   4.0 .014 .0182.000 .022 .0261.000 .010 .014
                3.0   4.0 .012 .0162.000 .020 .0241.000 .009 .013
                3.0   4.0 .010 .0142.000 .018 .0221.000 .008 .012
                3.0   4.0 .009 .0132.000 .017 .0211.000 .007 .011
```

TABLE 8. LISTING OF GENERATED DATA

```
GENERATED I/O

      6
       SAMPLE   *   GENERATE THE INPUT RUN   *                                  -0.
  1       0.00
  2       0.00
  3       4.24       -0.00
  4       4.24       -0.00
  5       1.39
  6       1.39
  7    1000.00
  8    4100.00
  9     150.00
 10     120.00
 11       3.00
      4          .012        .015
      2          .020        .024
      1          .006        .010
 12      11.74
 13      11.74
 14     500.00
 15      10.00
 16       1.00
 17      .0010
 18      .0010
 19       1.00
 20       1.00
      4
      0.00       1.00     51.00   120.00
  0.00   .19  1.00  2.00
       SAMPLE   *   GENERATE THE INPUT RUN   *                                  -0.
  7  2000.00
 11     3.00
      4          .011        .015
      2          .019        .023
      1          .005        .009
       SAMPLE   *   GENERATE THE INPUT RUN   *                                  -0.
  7  3000.00
 11     3.00
      4          .008        .012
      2          .016        .020
      1          .004        .009
       SAMPLE   *   GENERATE THE INPUT RUN   *                                  -0.
  7  4000.00
 11     3.00
      4          .006        .011
      2          .014        .018
      1          .003        .007
       SAMPLE   *   GENERATE THE INPUT RUN   *                                  -0.
  7  5000.00
 11     3.00
      4          .004        .009
      2          .012        .016
      1          .002        .006
       SAMPLE   *   GENERATE THE INPUT RUN   *                                  -0.
  7  6000.00
 11     3.00
      4          .003        .007
      2          .011        .015
      1          .001        .005
      6
       SAMPLE   *   GENERATE THE INPUT RUN   *                                  -0.
  7  1000.00
  9   250.00
 11     3.00
      4          .014        .018
      2          .022        .026
      1          .008        .012
 12    11.74
 13    11.74
       SAMPLE   *   GENERATE THE INPUT RUN   *                                  -0.
  7  2000.00
 11     3.00
      4          .013        .017
      2          .021        .025
      1          .007        .011
       SAMPLE   *   GENERATE THE INPUT RUN   *                                  -0.
  7  3000.00
 11     3.00
      4          .010        .014
      2          .018        .022
      1          .006        .011
       SAMPLE   *   GENERATE THE INPUT RUN   *                                  -0.
  7  4000.00
 11     3.00
      4          .008        .012
      2          .016        .020
      1          .005        .010
```

TABLE 8. LISTING OF GENERATED DATA (CONTINUED)

```
     SAMPLE   *   GENERATE THE INPUT RUN   *                        -0.
 7 5000.00
11    3.00
   4        .006        .010
   2        .014        .018
   1        .004        .009
     SAMPLE   *   GENERATE THE INPUT RUN   *                        -0.
 7 6000.00
11    3.00
   4        .005        .009
   2        .013        .017
   1        .003        .007

   6
     SAMPLE   *   GENERATE THE INPUT RUN   *                        -0.
 7 1000.00
 9  350.00
11    3.00
   4        .016        .020
   2        .024        .028
   1        .010        .014
12   11.74
13   11.74
     SAMPLE   *   GENERATE THE INPUT RUN   *                        -0.
 7 2000.00
11    3.00
   4        .015        .019
   2        .023        .027
   1        .009        .013
     SAMPLE   *   GENERATE THE INPUT RUN   *                        -0.
 7 3000.00
11    3.00
   4        .012        .016
   2        .020        .024
   1        .008        .012
     SAMPLE   *   GENERATE THE INPUT RUN   *                        -0.
 7 4000.00
11    3.00
   4        .010        .014
   2        .018        .022
   1        .007        .011
     SAMPLE   *   GENERATE THE INPUT RUN   *                        -0.
 7 5000.00
11    3.00
   4        .008        .012
   2        .016        .020
   1        .006        .010
     SAMPLE   *   GENERATE THE INPUT RUN   *                        -0.
 7 6000.00
11    3.00
   4        .007        .011
   2        .015        .019
   1        .005        .009

   6
     SAMPLE   *   GENERATE THE INPUT RUN   *                        -0.
 7 1000.00
 9  450.00
11    3.00
   4        .018        .022
   2        .026        .030
   1        .012        .016
12   11.74
13   11.74
```

TABLE 8. LISTING OF GENERATED DATA (CONCLUDED)

```
   SAMPLE   *   GENERATE THE INPUT RUN   *                         -0.
 7 2000.00
11    3.00
    4         .017        .021
    2         .025        .029
    1         .011        .015
   SAMPLE   *   GENERATE THE INPUT RUN   *                         -0.
 7 3000.00
11    3.00
    4         .014        .018
    2         .022        .026
    1         .010        .014
   SAMPLE   *   GENERATE THE INPUT RUN   *                         -0.
 7 4000.00
11    3.00
    4         .012        .016
    2         .020        .024
    1         .009        .013
   SAMPLE   *   GENERATE THE INPUT RUN   *                         -0.
 7 5000.00
11    3.00
    4         .010        .014
    2         .018        .022
    1         .008        .012
   SAMPLE   *   GENERATE THE INPUT RUN   *                         -0.
 7 6000.00
11    3.00
    4         .009        .013
    2         .017        .021
    1         .007        .011
```

TABLE 9. OUTPUT SAMPLE * GENERATE THE INPUT RUN *

COORDINATE	AIM ERROR (MILS)	BALLISTIC DISPERSION (MILS)
RANGE	4.2	1.4
DEFLECTION	4.2	1.4

AIRCRAFT SPEED (KIAS) = 150.
STEADY STATE FIRING RATE PER GUN (RDS/MIN) = 4100.
SLANT RANGE AT COMMENCE[redacted] OF FIRING RUN (FT) = 1000.
NO. OF ROUNDS PER PASS [redacted] GUN = 120
PROBABILITY OF JAMMING = .00100

TARGET LENGTH (FEET) = 11.7
TARGET WIDTH (FEET) = 11.7

NUMBER OF MONTE CARLO ITERATIONS = 500
NUMBER OF EMPTY PASSES THROUGH RANDOM NO. GENERATORS = 10
NUMBER OF GUN SYSTEMS CONSIDERED = 1

PROBABILITY OF TARGET KILL = .786
STANDARD DEVIATION OF THE MEAN = .0183

NO. OF RDS/GUN	CONDITIONAL KILL PROBABILITY	TIME	CORRELATION CONSTANTS RANGE	CORRELATION CONSTANTS DEFL	SLANT RANGE	KILL PROBABILITY
1	.012	.1800	0.000	0.000	954.	.008
2	.012	.1964	.975	.951	950.	.012
3	.012	.2128	.975	.951	945.	.016
4	.012	.2292	.975	.951	942.	.022
5	.020	.2456	.975	.951	938.	.034
6	.021	.2620	.975	.951	934.	.042
7	.007	.2784	.975	.951	930.	.044
8	.013	.2948	.975	.951	925.	.064
9	.013	.3112	.975	.951	921.	.070
10	.013	.3276	.975	.951	917.	.074
11	.013	.3440	.975	.951	913.	.092
12	.021	.3604	.975	.951	909.	.096
13	.021	.3768	.975	.951	905.	.114
14	.007	.3932	.975	.951	900.	.116
15	.013	.4096	.975	.951	896.	.118
16	.013	.4260	.975	.951	892.	.134
17	.013	.4424	.975	.951	888.	.136
18	.013	.4588	.975	.951	884.	.142
19	.021	.4752	.975	.951	880.	.156
20	.021	.4916	.975	.951	876.	.178
21	.007	.5080	.975	.951	871.	.184
22	.013	.5244	.975	.951	867.	.198
23	.013	.5408	.975	.951	863.	.212
24	.013	.5572	.975	.951	859.	.218
25	.013	.5736	.975	.951	855.	.226
26	.021	.5900	.975	.951	851.	.230
27	.021	.6064	.975	.951	846.	.248
28	.007	.6228	.975	.951	842.	.252
29	.013	.6392	.975	.951	838.	.260
30	.013	.6556	.975	.951	834.	.270
31	.013	.6720	.975	.951	830.	.278
32	.013	.6884	.975	.951	826.	.290
33	.021	.7048	.975	.951	822.	.296
34	.021	.7212	.975	.951	817.	.310
35	.007	.7376	.975	.951	813.	.314
36	.014	.7540	.975	.951	809.	.324
37	.014	.7704	.975	.951	805.	.334
38	.014	.7868	.975	.951	801.	.342
39	.014	.8032	.975	.951	797.	.350
40	.022	.8196	.975	.951	792.	.352
41	.022	.8360	.975	.951	788.	.374
42	.008	.8524	.975	.951	784.	.376
43	.014	.8688	.975	.951	780.	[illegible]
44	.014	.8852	.975	.951	776.	.394
45	.014	.9016	.975	.951	772.	.398
46	.014	.9180	.975	.951	768.	.394
47	.022	.9344	.975	.951	763.	[illegible]
48	.022	.9508	.975	.951	759.	[illegible]
49	.008	.9672	.975	.951	755.	[illegible]
50	.014	.9836	.975	.951	751.	[illegible]
51	.014	1.0000	.975	.951	747.	.430
52	.014	1.0145	.978	.954	743.	.432
53	.014	1.0290	.978	.954	739.	.442

TABLE 9. OUTPUT SAMPLE * GENERATE THE INPUT RUN * (CONCLUDED)

NO. OF RDS/GUN	CONDITIONAL KILL PROBABILITY	TIME	CORRELATION CONSTANTS RANGE	CORRELATION CONSTANTS DEFL	SLANT RANGE	KILL PROBABILITY
54	.022	1.0435	.978	.954	736.	.448
55	.022	1.0580	.978	.954	732.	.458
56	.008	1.0725	.978	.954	728.	.462
57	.014	1.0870	.978	.954	725.	.464
58	.014	1.1014	.978	.954	721.	.472
59	.014	1.1159	.978	.954	717.	.476
60	.014	1.1304	.978	.954	714.	.478
61	.022	1.1449	.978	.954	710.	.496
62	.022	1.1594	.978	.954	706.	.502
63	.008	1.1739	.978	.954	703.	.504
64	.014	1.1884	.978	.954	699.	.506
65	.014	1.2029	.978	.954	695.	.518
66	.014	1.2174	.978	.954	692.	.524
67	.014	1.2319	.978	.954	688.	.532
68	.022	1.2464	.978	.954	684.	.538
69	.023	1.2609	.978	.954	681.	.550
70	.009	1.2754	.978	.954	677.	.554
71	.015	1.2899	.978	.954	673.	.556
72	.015	1.3043	.978	.954	670.	.566
73	.015	1.3188	.978	.954	666.	.566
74	.015	1.3333	.978	.954	662.	.572
75	.023	1.3478	.978	.954	659.	.590
76	.023	1.3623	.978	.954	655.	.592
77	.009	1.3768	.978	.954	651.	.598
78	.015	1.3913	.978	.954	648.	.598
79	.015	1.4058	.978	.954	644.	.598
80	.015	1.4203	.978	.954	640.	.604
81	.015	1.4348	.978	.954	637.	.612
82	.023	1.4493	.978	.954	633.	.616
83	.023	1.4638	.978	.954	629.	.618
84	.009	1.4783	.978	.954	626.	.618
85	.015	1.4928	.978	.954	622.	.624
86	.015	1.5072	.978	.954	618.	.628
87	.015	1.5217	.978	.954	615.	.634
88	.015	1.5362	.978	.954	611.	.638
89	.023	1.5507	.978	.954	607.	.644
90	.023	1.5652	.978	.954	604.	.650
91	.009	1.5797	.978	.954	600.	.652
92	.015	1.5942	.978	.954	596.	.654
93	.015	1.6087	.978	.954	593.	.658
94	.015	1.6232	.978	.954	589.	.662
95	.015	1.6377	.978	.954	585.	.668
96	.023	1.6522	.978	.954	582.	.684
97	.023	1.6667	.978	.954	578.	.690
98	.009	1.6812	.978	.954	574.	.690
99	.015	1.6957	.978	.954	571.	.692
100	.015	1.7101	.978	.954	567.	.692
101	.015	1.7246	.978	.954	563.	.698
102	.015	1.7391	.978	.954	560.	.702
103	.024	1.7536	.978	.954	556.	.710
104	.024	1.7681	.978	.954	552.	.716
105	.010	1.7826	.978	.954	549.	.716
106	.016	1.7971	.978	.954	545.	.726
107	.016	1.8116	.978	.954	541.	.734
108	.016	1.8261	.978	.954	538.	.738
109	.016	1.8406	.978	.954	534.	.748
110	.024	1.8551	.978	.954	530.	.750
111	.024	1.8696	.978	.954	527.	.754
112	.010	1.8841	.978	.954	523.	.756
113	.016	1.8986	.978	.954	519.	.760
114	.016	1.9130	.978	.954	516.	.766
115	.016	1.9275	.978	.954	512.	.770
116	.016	1.9420	.978	.954	508.	.774
117	.024	1.9565	.978	.954	505.	.778
118	.024	1.9710	.978	.954	501.	.778
119	.010	1.9855	.978	.954	497.	.790
120	.016	2.0000	.978	.954	494.	.796

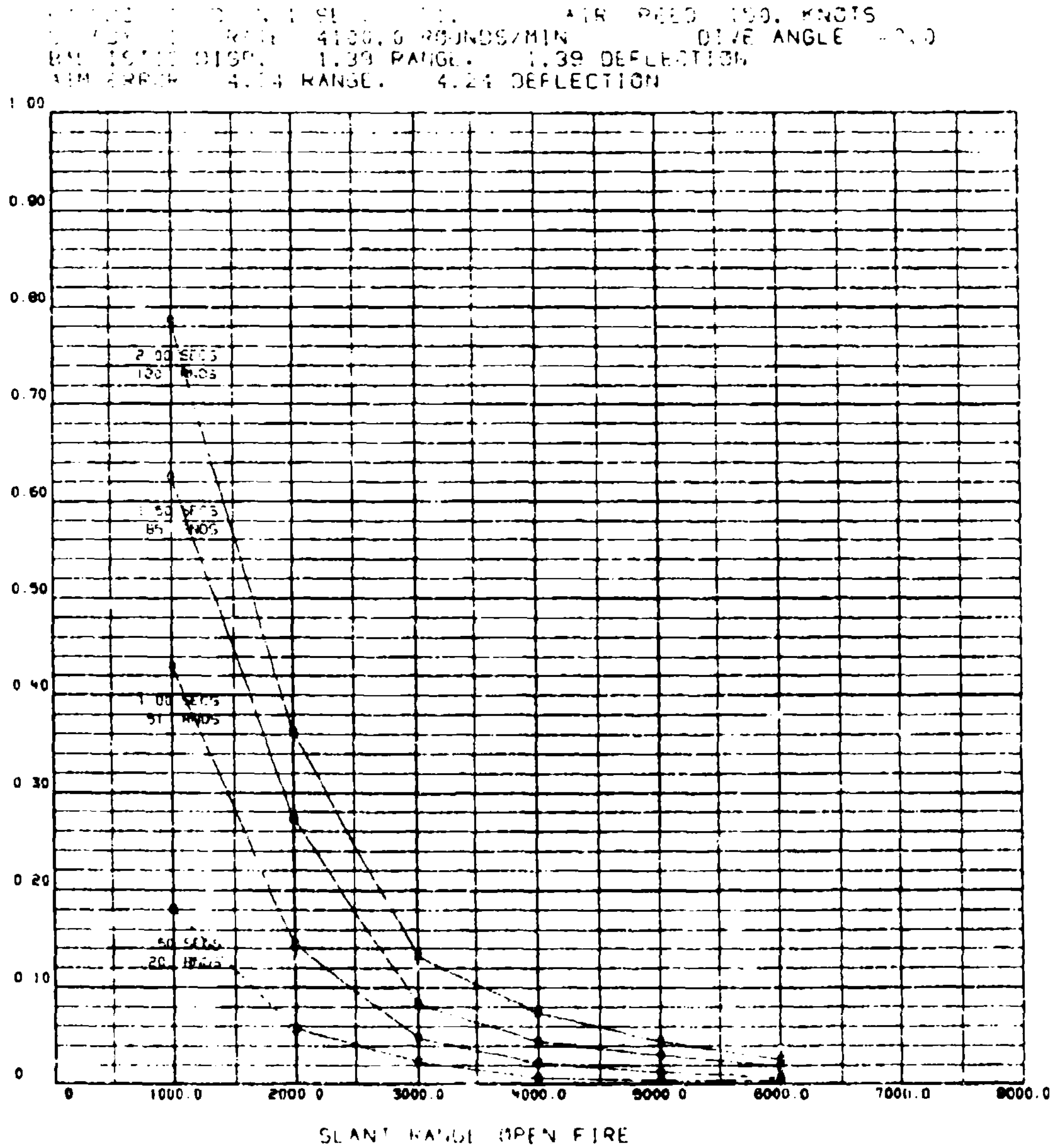

Figure 6. Filmplot Output Sample for Generate the Input Run

SECTION VII

STAND ALONE PLOT

There may be times when the probability of kill values are known but no plots were made. This section becomes a back-up plot option when this occurs. The P_K's can be keypunched and plotted with a minimum computer and turn around times. Without this option the analyst would have to resubmit the computer run with the plot option turned on or plot the P_K's by hand. Table 10 describes the set-up and Table 11 is a sample set-up. Figure 7 is the filmplot output for the stand alone plot.

TABLE 10. DESCRIPTION OF THE SET-UP FOR A STAND ALONE PLOT

Card	Columns	Variable	Limits	Description	Units
1	1	IPLOT	2	2 = Stand alone plot	
2	1-5	TCODE		Description of the target	
	6-10	WCODE		Description of the weapon	
	11-20	RPS		Number of rounds fired in one second	
	21-30	C		Aircraft speed	knots
	31-40	R		Steady state firing rate of gun	rnds/min
	41-50	DIVE		Aircraft dive angle	degrees
	51-60	BURSTL		Burst length	secs
	61-70	RNDSTL		Total rounds fired	
3	1-10	SIGR		Standard deviation of aim error in range	mils
	11-20	SIGD		Standard deviation of aim error in deflection	mils
	21-30	BETAR		Standard deviation of ballistic error in range	mils
	31-40	BETAD		Standard deviation of ballistic error in deflection	mils
4	1-10	CPK(1)		Probability of target kill for 1000 ft slant range	
	11-20	CPK(2)		Probability of target kill for 2000 ft slant range	
	21-30	CPK(3)		Probability of target kill for 3000 ft slant range	
	31-40	CPK(4)		Probability of target kill for 4000 ft slant range	
	41-50	CPK(5)		Probability of target kill for 5000 ft slant range	
	51-60	CPK(6)		Probability of target kill for 6000 ft slant range	
	61-70	PTITLE		Label for this curve on graph	
	NOTE: Repeat card 4 for additional curves on same graph.				
5				Blank card	

NOTE: A blank card follows the last curve card on graph - for additional graphs repeat card 2 thru 4. The number of plots are unlimited.

Table 11. SAMPLE SET-UP FOR 'STAND ALONE PLOT'

	1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
1	2							
2	APC 30MM	51	350	4100	30	2	120	
3	4.24	4.24	2.0	2.0				
4	1.00	.86	.56	.19	.13	.08	A	
5	.90	.77	.45	.17	.10	.05	B	
6	.80	.65	.30	.12	.08	.04	C	
7	.70	.50	.20	.08	.06	.03	D	
8	.60	.40	.15	.05	.03	.02	E	
9	.50	.32	.10	.03	.02	.01	F	
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

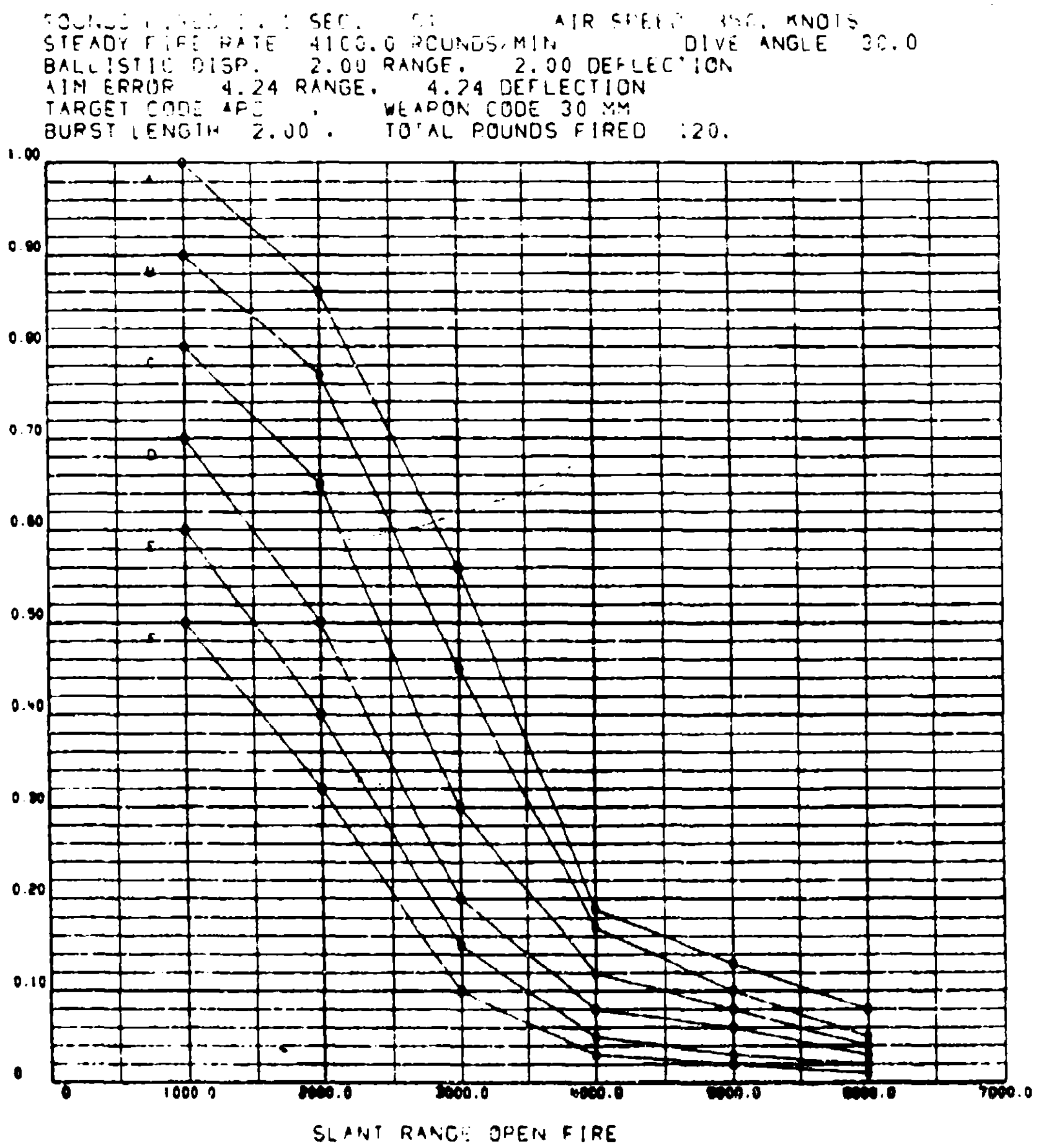

Figure 7. Filmplot Output Sample for Stand Alone Plot

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REFERENCES

1. Operations Evaluation Group Research Contribution No. 43, "Air-to-Ground Gunnery Simulation; OEG Computer Program 18-63P," OEG Center for Naval Analyses, Washington, D.C., 5 August 1963, Unclassified.

2. Aim Wander Correlation in Air-to-Ground Gunnery, R. V. Ridings, OEG-RC 63, Operation Evaluations Group, Center for Naval Analyses, Washington, D.C., 3 December 1964, Unclassified.

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APPENDIX A

FORTRAN VARIABLE LIST

This appendix contains a list of input, output, and intermediate FORTRAN variables used in the mathematical computation overlay 1,0.

FORTRAN Variable	Description
A,D(1)	Correlation coefficient in range - input variable.
AI	An intermediate variable used to check to see if the time-to-rate table is correct.
ALPHA	A random normal number used to determine the aim point in range.
AM	Intermediate aim error value in range.
AM1	Intermediate aim error value in deflection.
B,D(2),PD(J)	Correlation coefficient in deflection - input variable.
BBB,TEMP	Intermediate aim error value in range.
BBC	Intermediate aim error value in deflection.
BETAD,D(6)	Standard deviation of ballistic error in deflection - input variable.
BETAR,D(5)	Standard deviation of ballistic error in range - input variable.
BURSTL	Burst length input variable for plot only option.
C,D(9)	Input and output variable for the aircraft speed in knots.
CPK(I)	Conditional kill probability, or probability that a hit kills - output variable.
COUNT,I2	The number of times the program goes through the Monte Carlo loop.
CPK1(I)	1st conditional kill value using a mixed ammo belt.
CPK2(I)	2nd conditional kill value using a mixed ammo belt.
CPK3(I)	3rd conditional kill value using a mixed ammo belt.
CP1(I)	Starting conditional kill value at the beginning of firing run.
CPN(I)	End conditional kill value at the end of firing run.
DC	Aim point of the first round in deflection.
DELTA	Random normal number used to check the ballistic error in range.

FORTRAN Variable	Description
DIVE	Dive angle (for information only), input, and output variable.
DN,D(16)	Output print increment in burst length - input variable.
DQ	An intermediate value used to calculate time into burst for each round.
DT	Time increment between rounds in a burst.
DUMMY	Acts as a return variable to mix the random number generator not used in computation.
E,D(17)	Maximum allowable error for standard deviation of the mean-input variable.
EPS	Random normal number used to check the ballistic error in deflection.
F,D(14)	Maximum number of Monte Carlo iterations - input and output variable.
FF(I)	Output probability of kill for each round (ΔN).
FL,D(12)	Target length in feet-input and output variable.
FLN2,FLR2(I)	Half of target length in mils.
FLR2(I)=TEMP	Half of target length in mils.
FN,D(10)	Attempted number of rounds fired on a single pass - input variable.
GAMMA	Random normal number used to determine the aimpoint in deflection.
GUNN	Intermediate variable used to increment gun systems.
GUNS,D(19)	Number of gun systems considered - input variable.
IAIM	Number of sets of aiming errors - input variable.
I1	Initial value of the index for the Monte Carlo loop.
I2,Q	Test value of the index for the Monte Carlo loop ($\geq$200). Each iteration represents one pass at the target.
IDN,DN	Intermediate variable for burst length increment.

FORTRAN Variable	Description
JSTR,JSTP	The initial and index values for the DO loop that deals with the 3 belt mix, or 3 conditional kill values for 1 pass.
K	An integer value calculated for each round in the burst.
KN	Integer value of rounds per pass per gun - output variable.
L	Integer value of the address on the input cards.
LINE	Integer value used to determine the number of lines to be printed on a page.
LS	Integer used in an intermediate calculation of the conditional kill probabilities of a mixed belt set up.
LST,INC	Intermediate integer used with a mixed belt conditional kill probability set up.
N	Attempted number of rounds fired on a single pass.
NCASES	Number of cases to be plotted.
NEMP,D(15)	Number of empty passes through random number generator - input and output variable.
NKILLS	Number of kills or successful passes.
NOT	Number of pairs of entries in the time-to-rate table.
NSLANT	The number of slant ranges to be plotted on one graph.
NTS	Number of burst lengths to be plotted.
NTYPE	The number of types of mixed belts.
NUMR(I)	The number of consecutive rounds using this conditional kill probability.
P,D(11)	Input conditional kill probability
PD(I)	Correlation coefficient array in deflection.
PJAM,D(18)	Probability that the gun jams - input variable.
PK	Probability of target kill - output variable.
PKPLOT(I)	An intermediate value used to plot the PK's.

FORTRAN Variable	Description
PM2	The end parameter on the input data card if it has one.
PRMTR	The parameter after the address on each input data card.
PP	A random number used to test against the conditional kill value to see if the target was killed.
PR(I)	Correlation coefficient array in range.
PTITLE	Title for the plots for the plot only option in the program.
Q	The updated value for the index of the Monte Carlo loop.
R,D(8)	Steady state firing rate per gun in rounds per min - input and output variable.
RC	Aim point of the first round in range.
RD(I),RPS	Rounds per second for stand alone plot.
RNSTL	Total rounds fired - used on plot only option - input and output variable.
RPS	Rounds fired in one second - input and output variable for plot option.
RPS1(J),IR	The round number array for plotting.
S,D(7)	Slant range - input and output
SDPK	Output variable for the standard deviation of the mean - used to test accuracy of probability of kill.
SGD1	End input value for the standard deviation aim error in deflection.
SGR1	End input value for the standard deviation aim error in range.
SIGD,D(4)	Standard deviation of aim error in deflection - input and output variable.
SIGD1(I)	An intermediate array variable for the standard deviation aim error in deflection.
SIGR,D(3)	Standard deviation of aim error in range - input and output
SIGR1(I)	An intermediate array variable for the standard deviation aim error in range.

FORTRAN Variable	Description
SLR(I)	Output array variable for slant range at the time each round is fired.
T(1)	Intermediate time array variable.
TCODE	Target code for the plot option only - input and output variable.
TD(I)	Delta time array between rounds.
TD2	TD(I) squared - this variable is used to find the range and deflection correlation coefficients.
TEMT	Intermediate variable which converts 1/2 the target length to mils.
TEMW	Intermediate variable which converts 1/2 the target width to mils.
TEST	An intermediate variable used in the look-up table.
TIME(I)	Time value array for the time-to-rate table.
TITLE	Description of the output in 60 characters or less.
TPLOT	An array that contains the burst lengths to be plotted.
V	The variable where knots are converted to feet per second.
VR	An intermediate variable that determines the distance plane traveled between rounds fired.
W,D(13)	Target width in feet - input and output variable.
WCODE	Weapon code used as an input - output variable in the stand alone plot.
WN2,WR2(I)	Half of target width in mils.
X	Probability that the gun jams.
XX	Random number used to test against X to see if the gun jammed.

APPENDIX

FLOW CHART FOR OVERLAY 1,0

This appendix contains the flow chart for the mathematical computation section of the gun simulation program.

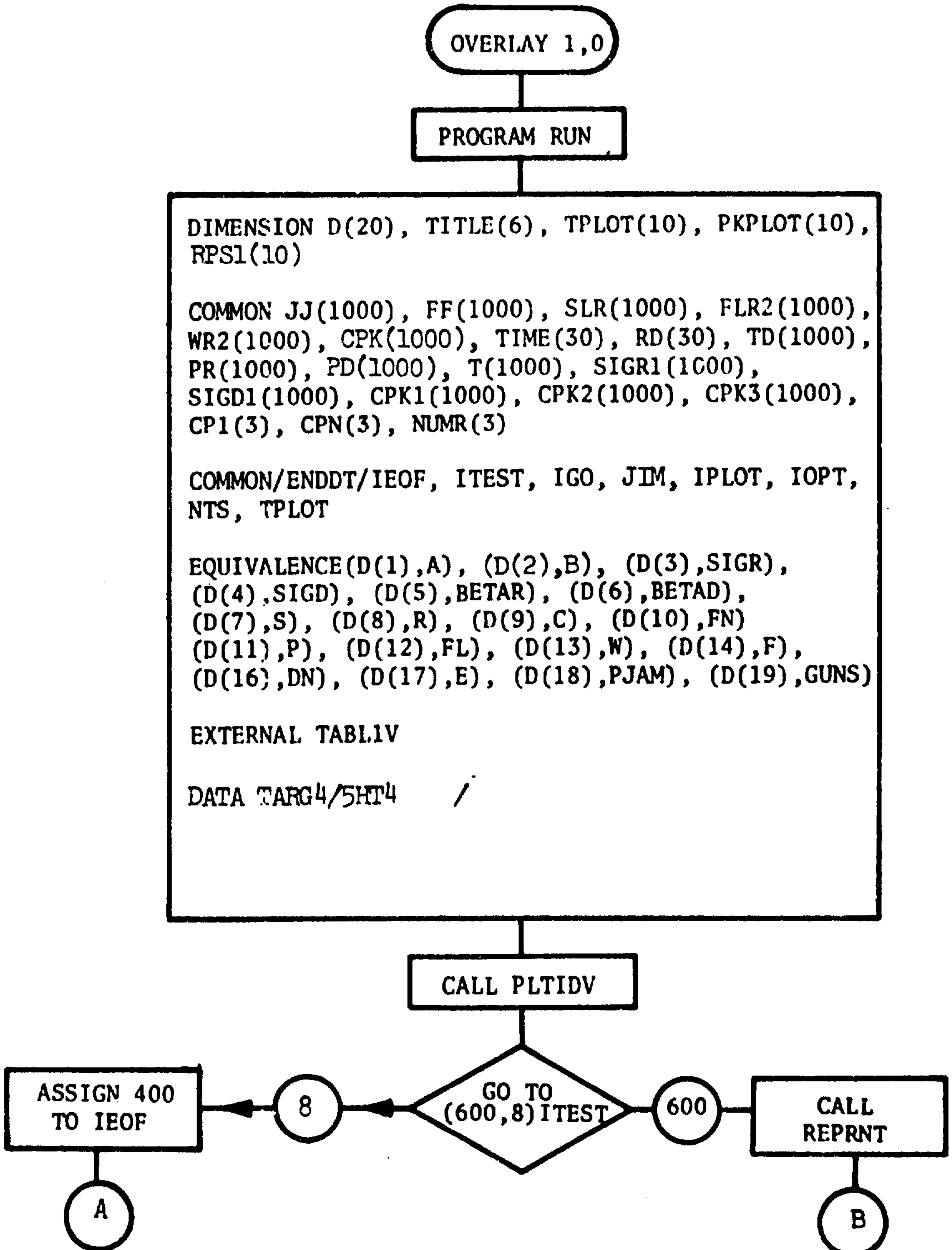

Figure 8. Flow Chart of Overlay 1,0

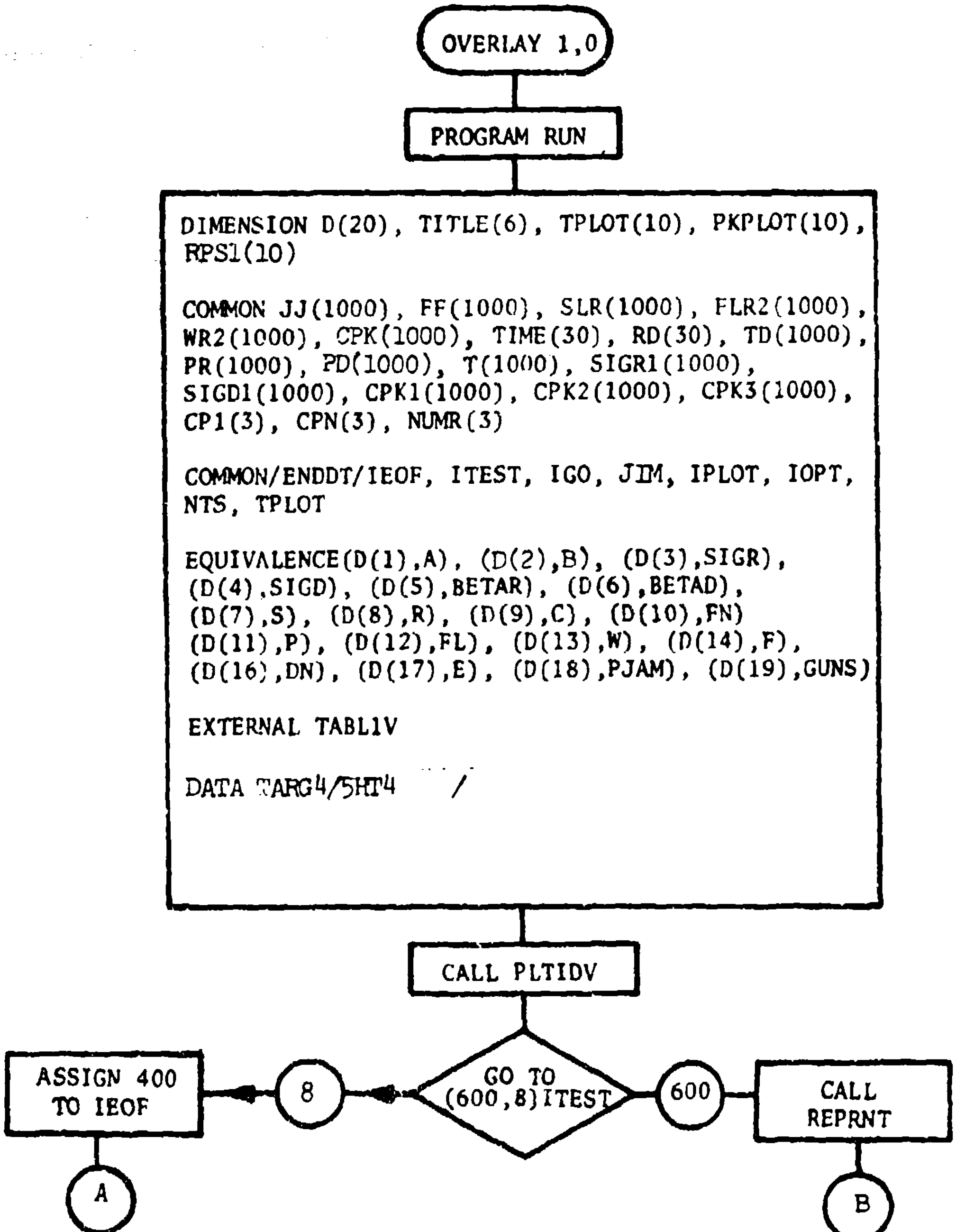

Figure 8. Flow Chart of Overlay 1,0

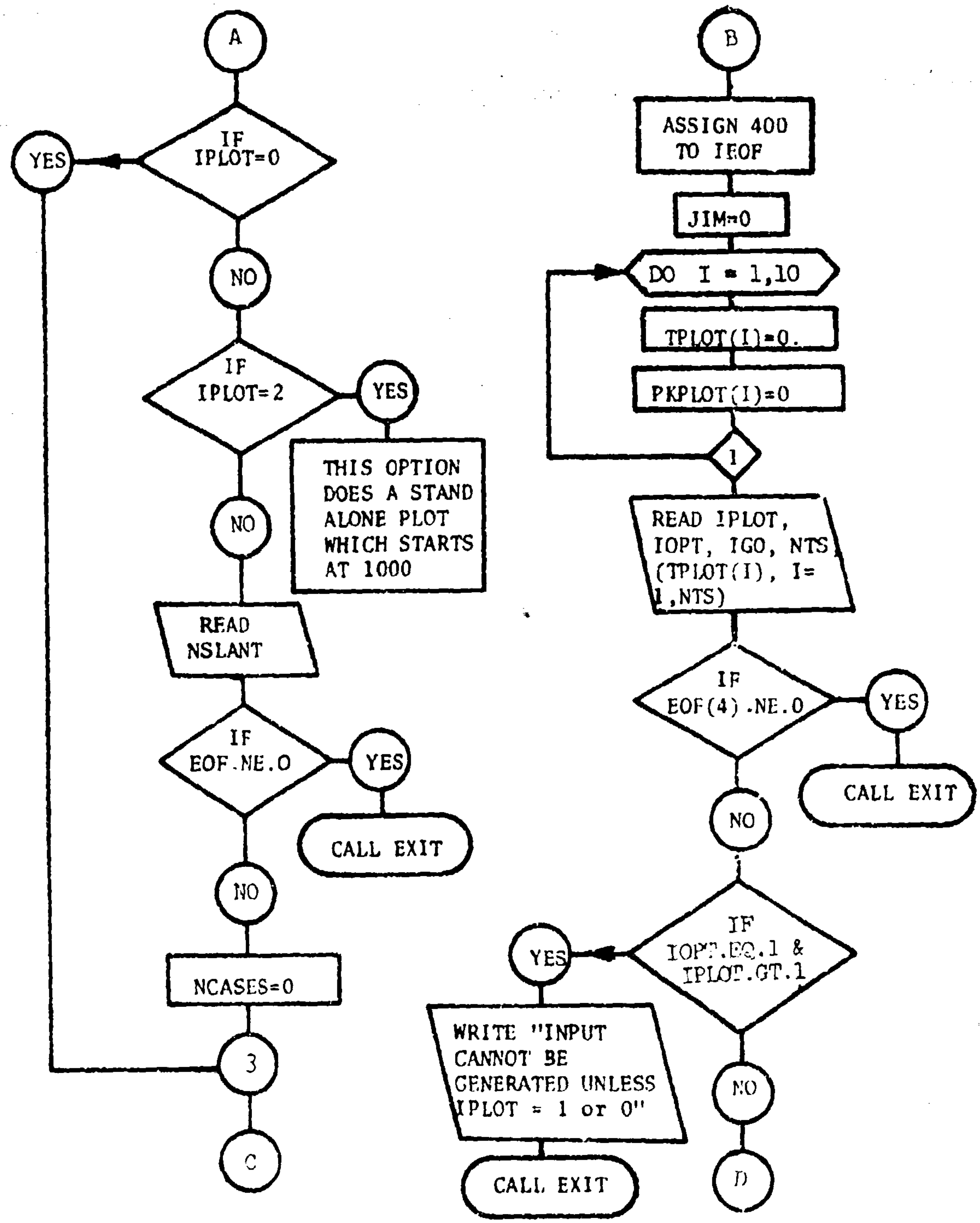

Figure 8. Flow Chart of Overlay 1,0 (Continued)

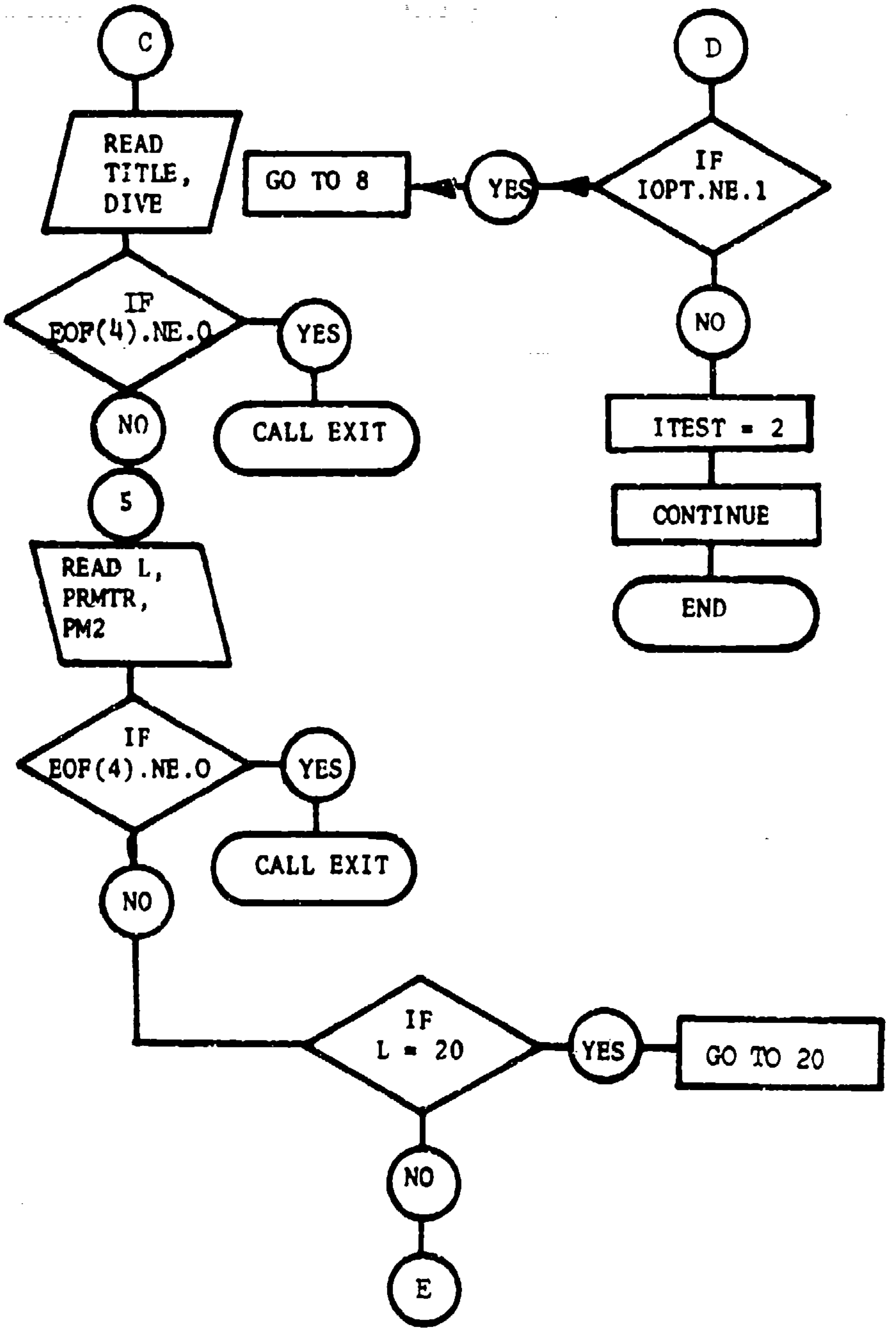

Figure 8. Flow Chart of Overlay 1,0 (Continued)

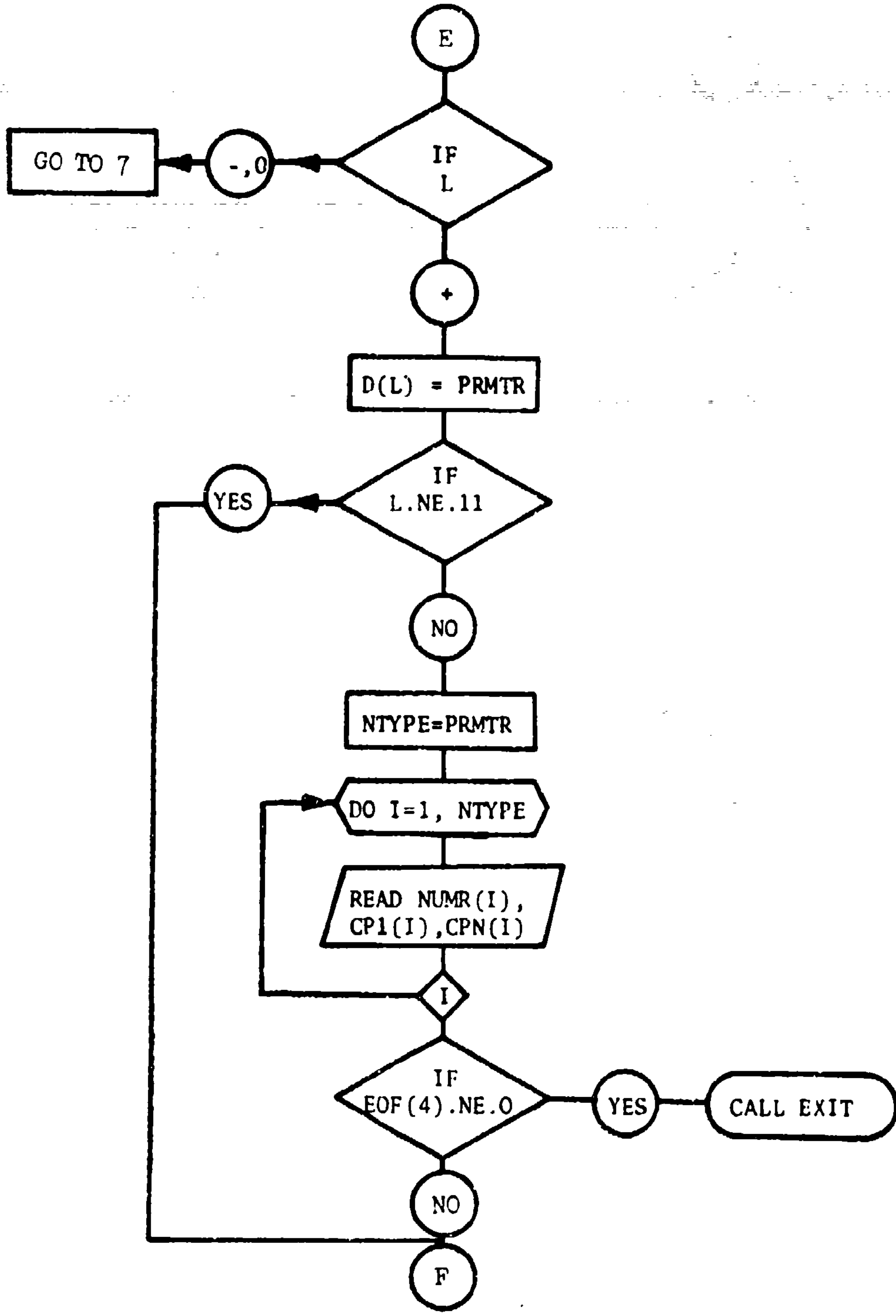

Figure 8. Flow Chart of Overlay 1,0 (Continued)

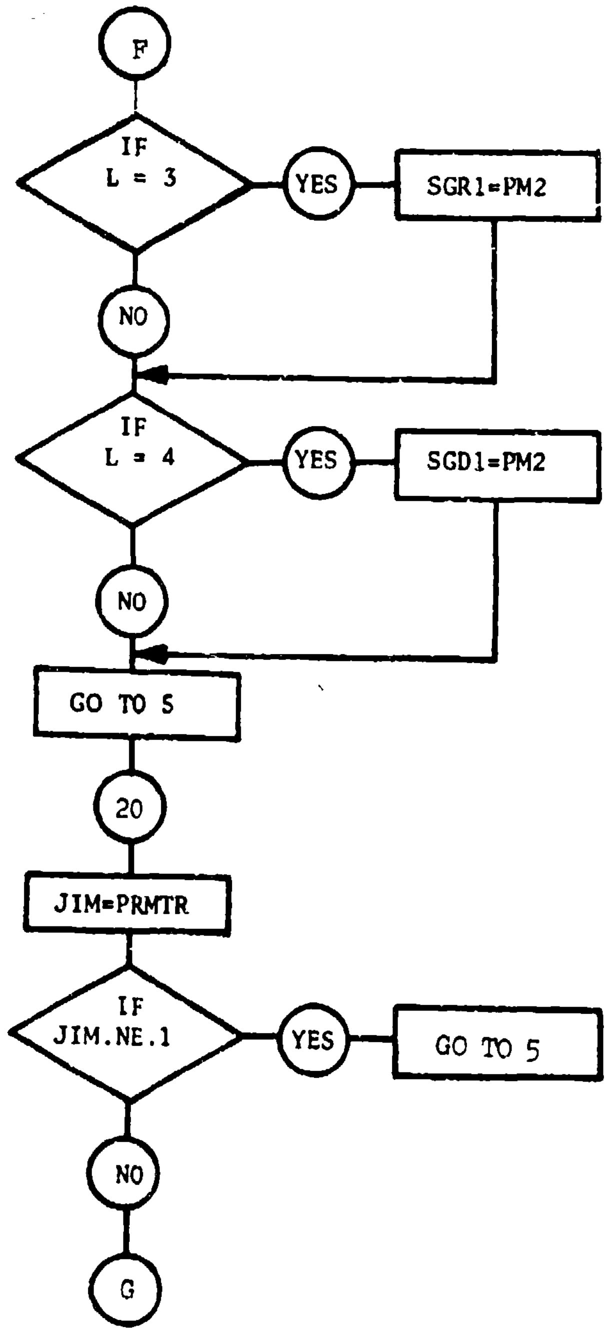

Figure 8. Flow Chart of Overlay 1,0 (Continued)

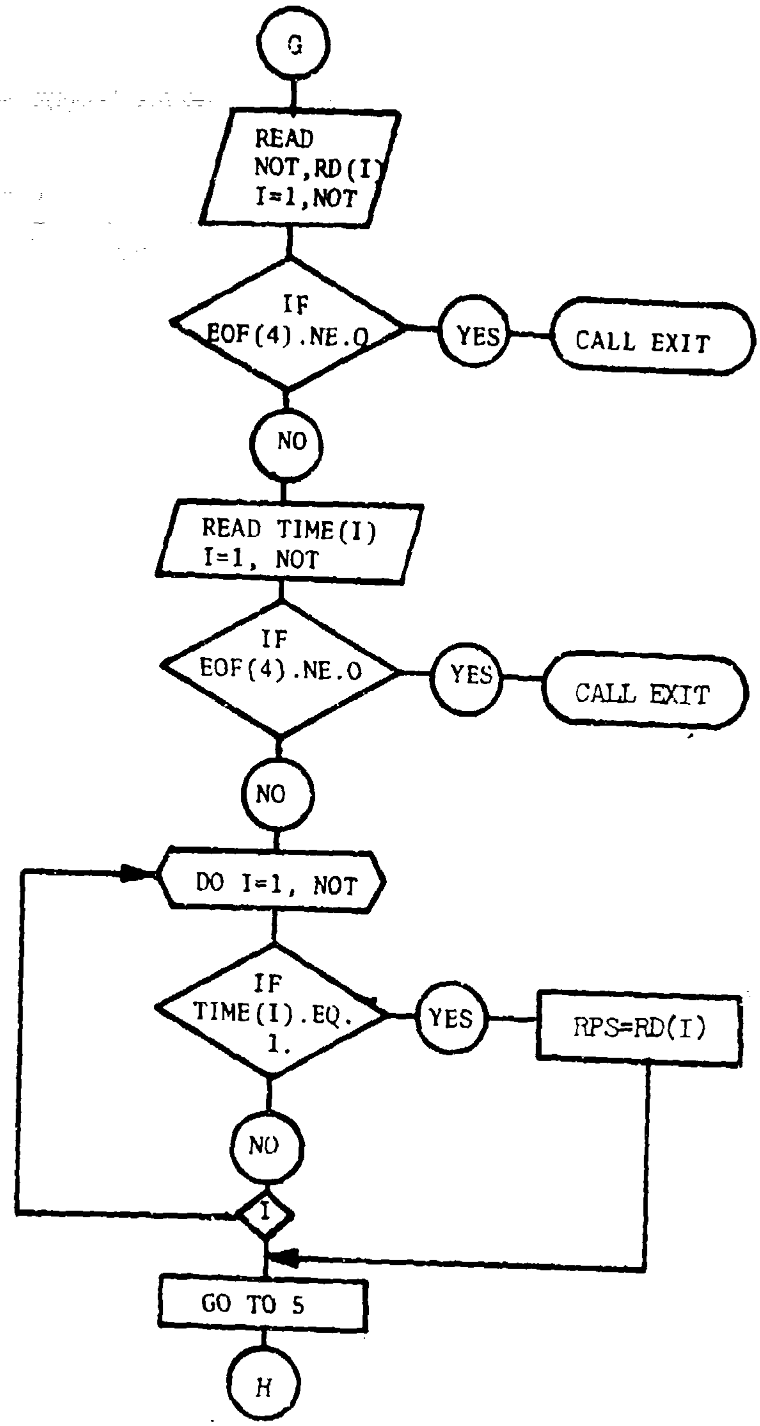

Figure 8. Flow Chart of Overlay 1,0 (Continued)

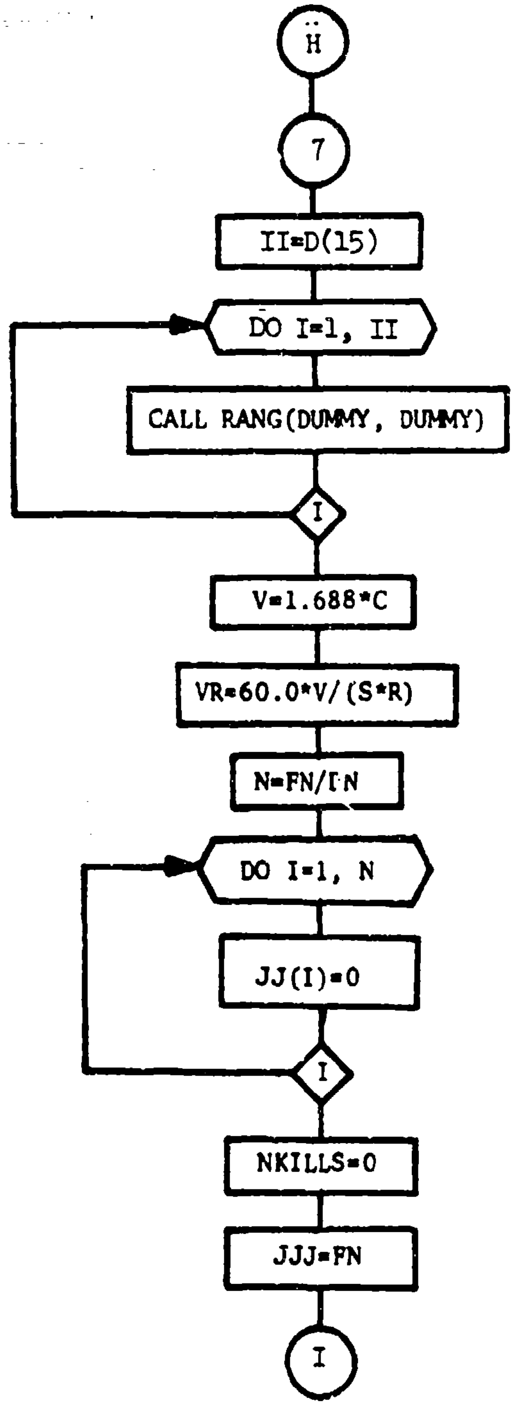

Figure 8. Flow Chart of Overlay 1,0 (Continued)

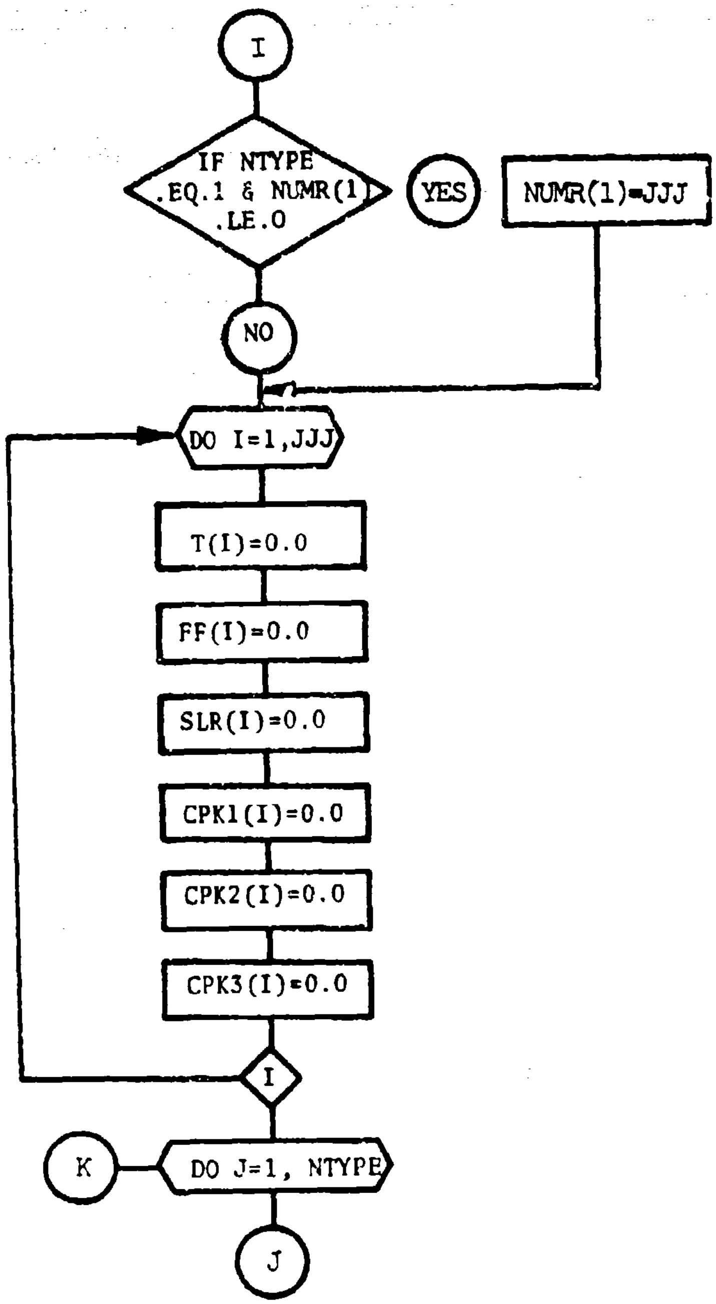

Figure 8. Flow Chart of Overlay 1,0 (Continued)

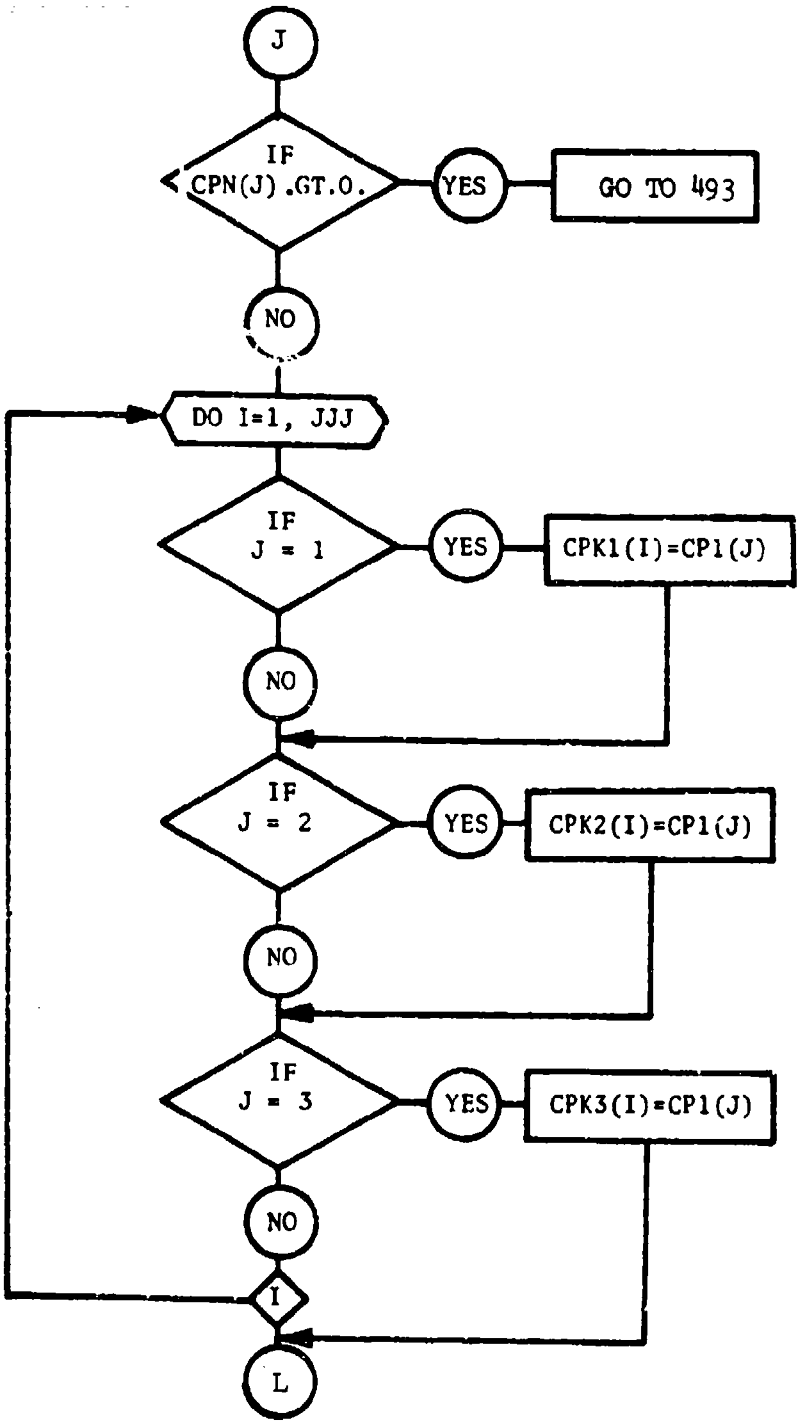

Figure 8. Flow Chart of Overlay 1,0 (Continued)

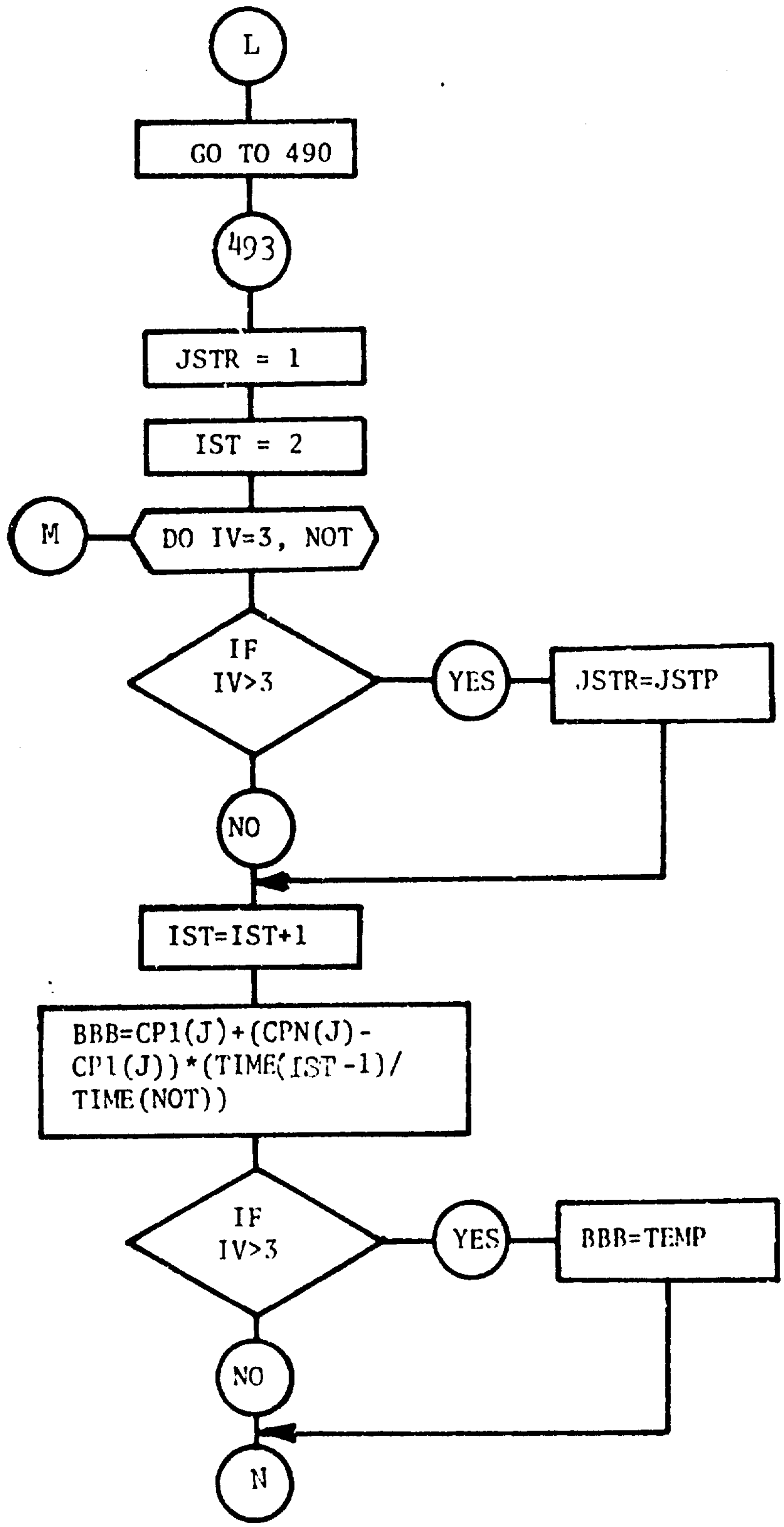

Figure 8. Flow Chart of Overlay 1,0 (Continued)

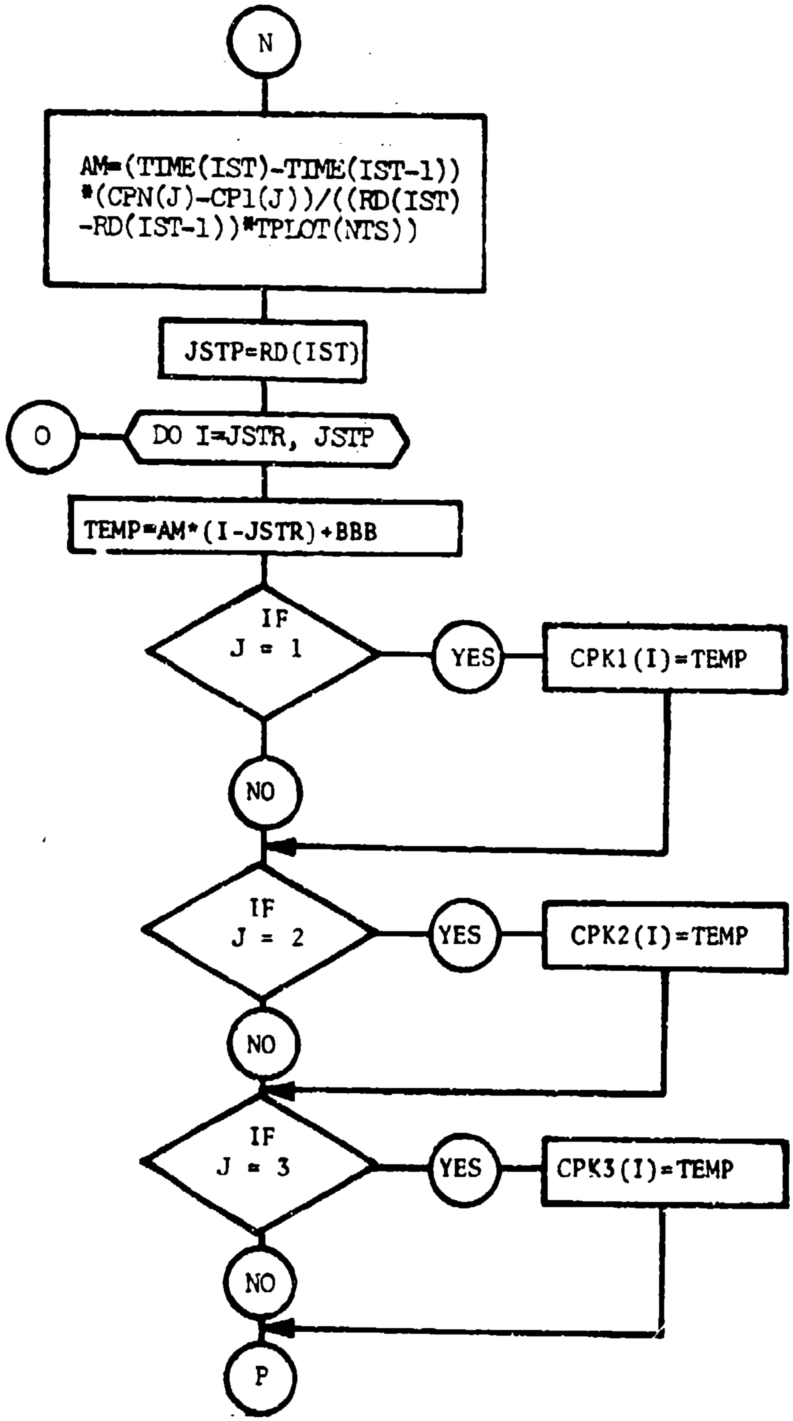

Figure 8. Flow Chart of Overlay 1,0 (Continued)

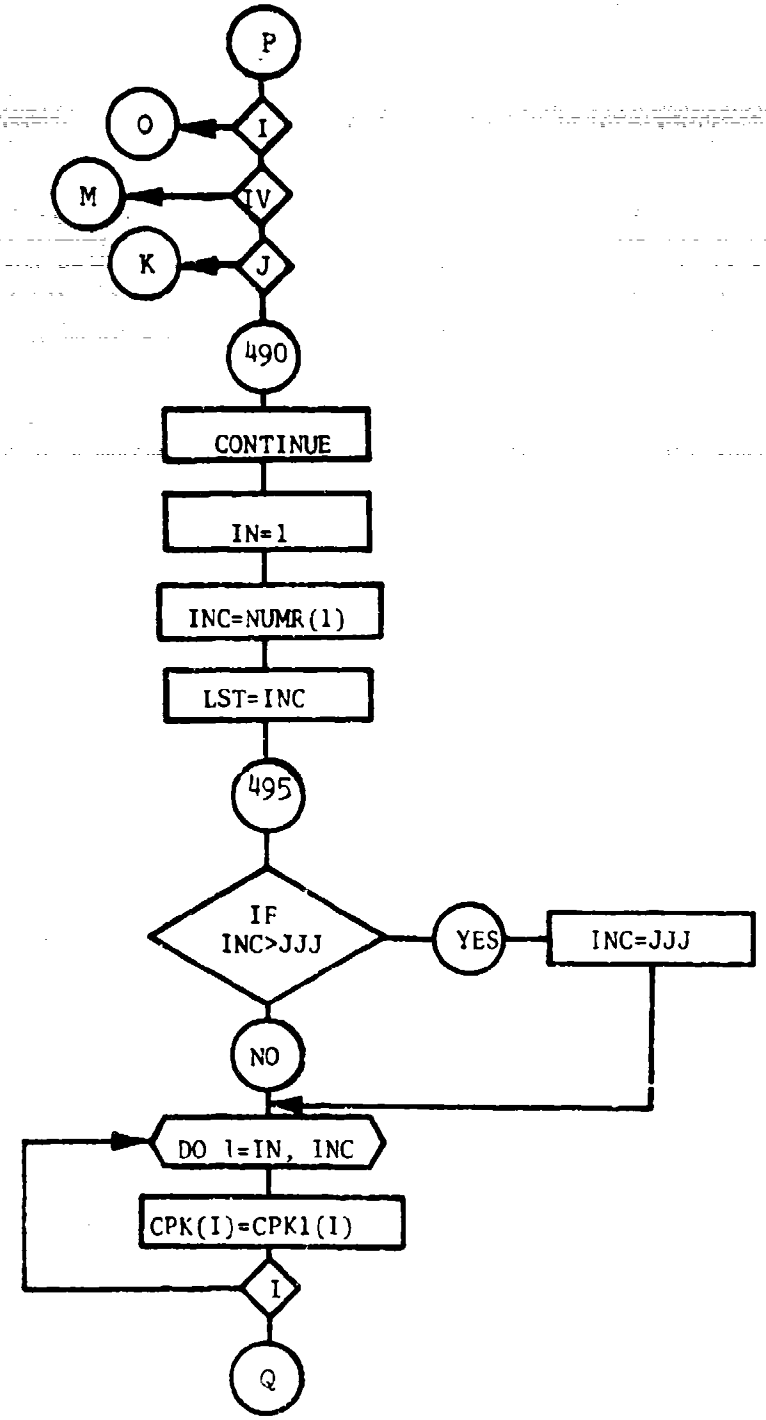

Figure 8. Flow Chart of Overlay 1,0 (Continued)

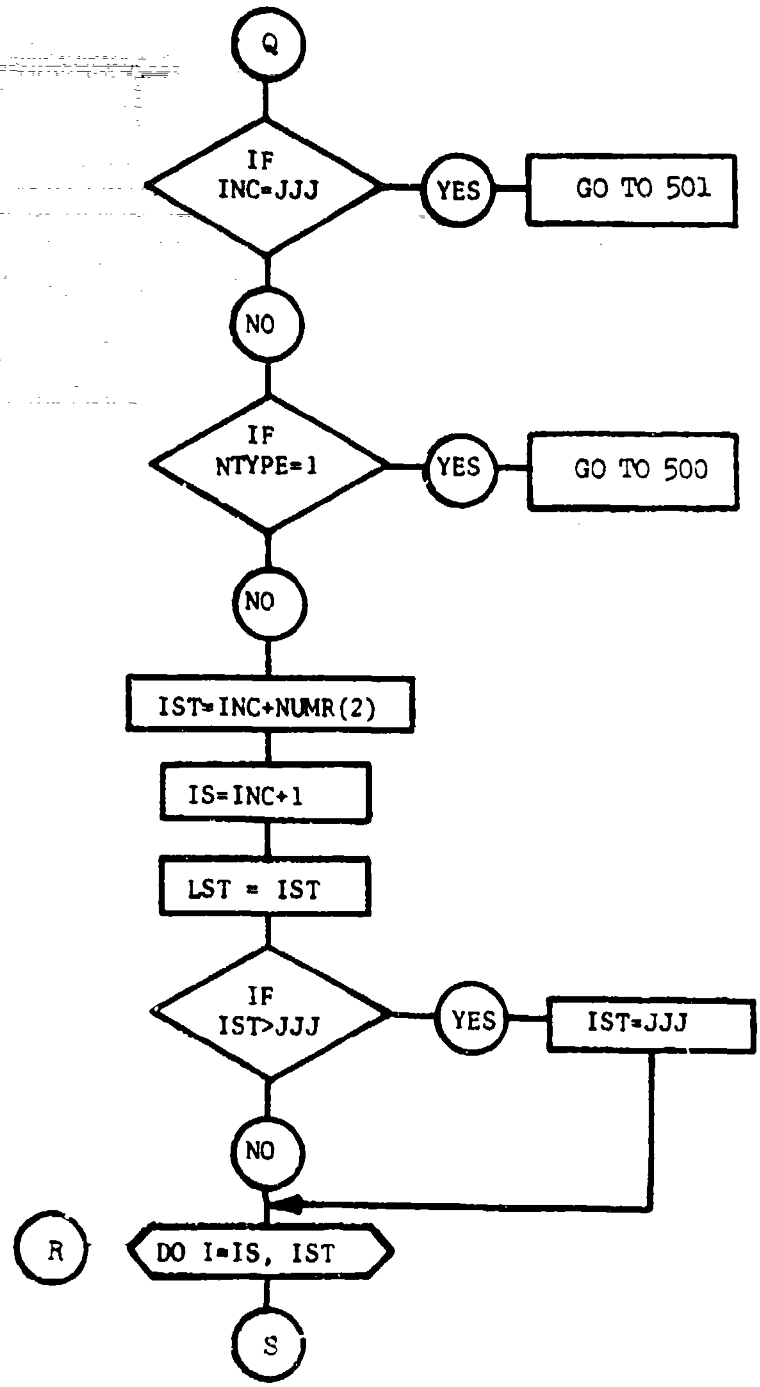

Figure 8. Flow Chart of Overlay 1,0 (Continued)

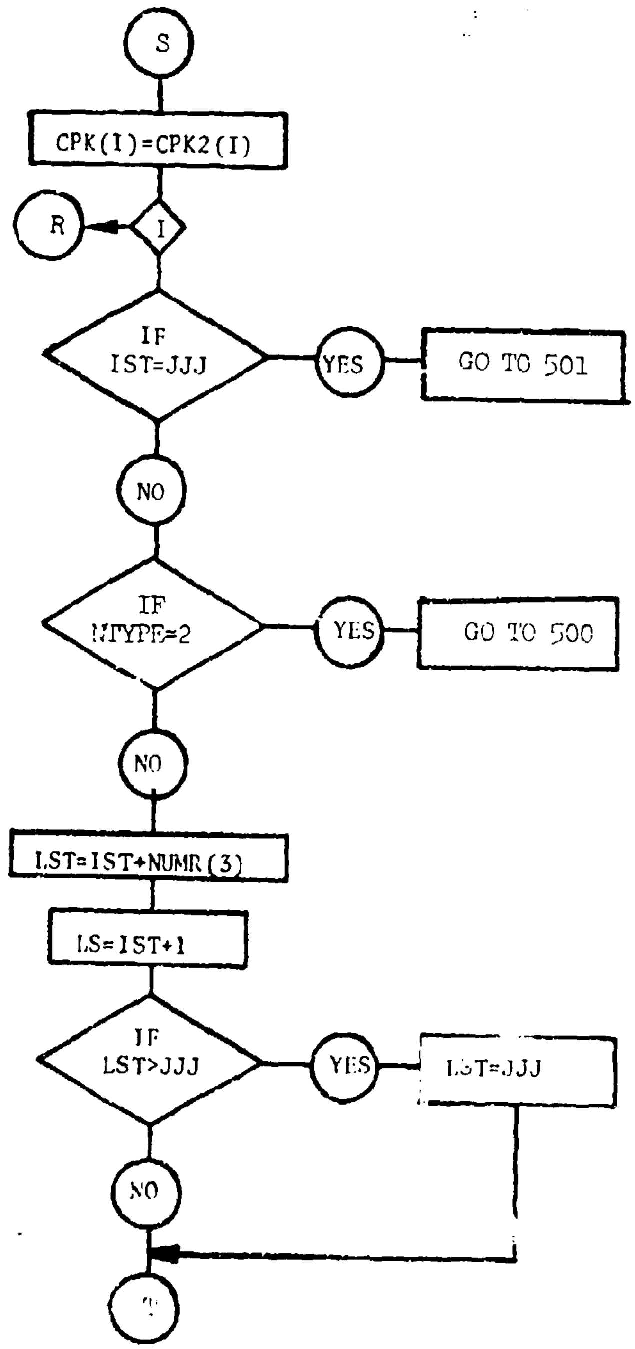

Figure 8. Flow Chart of Overlay 1,0 (Continued)

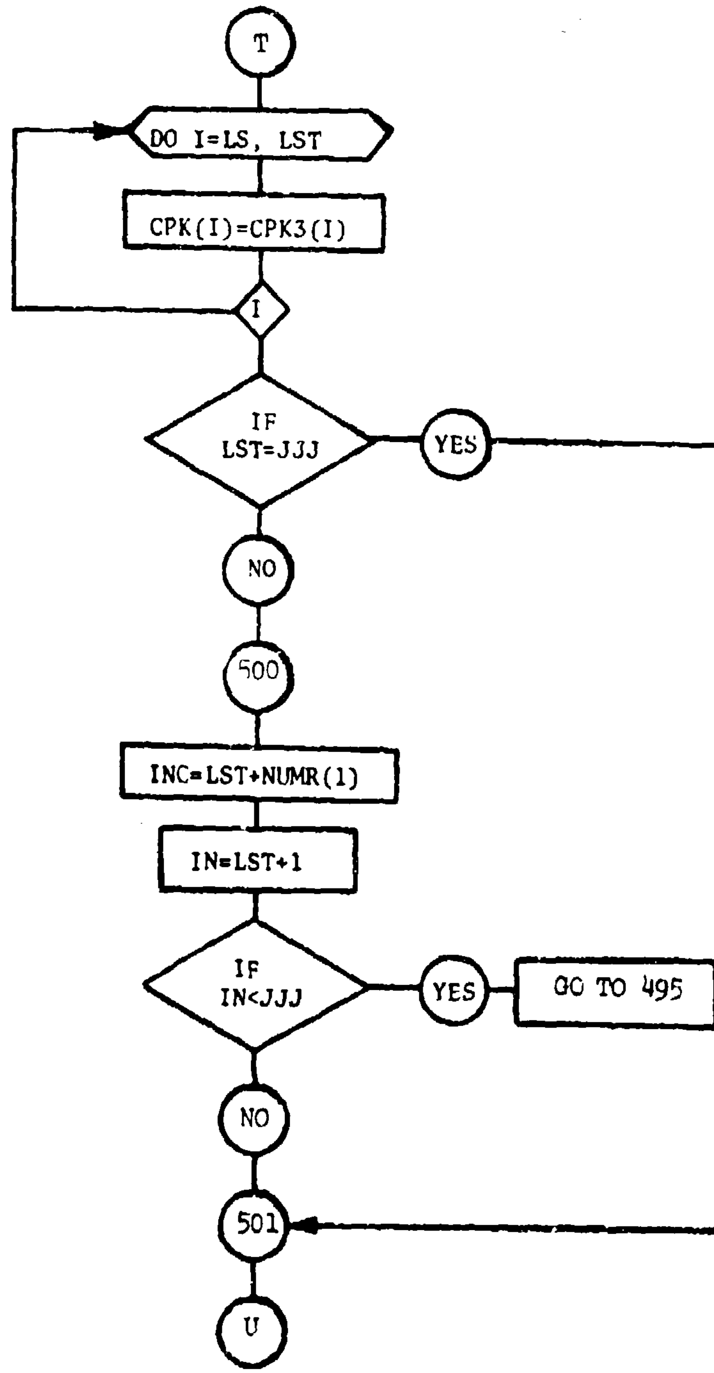

Figure 8. Flow Chart of Overlay 1,0 (Continued)

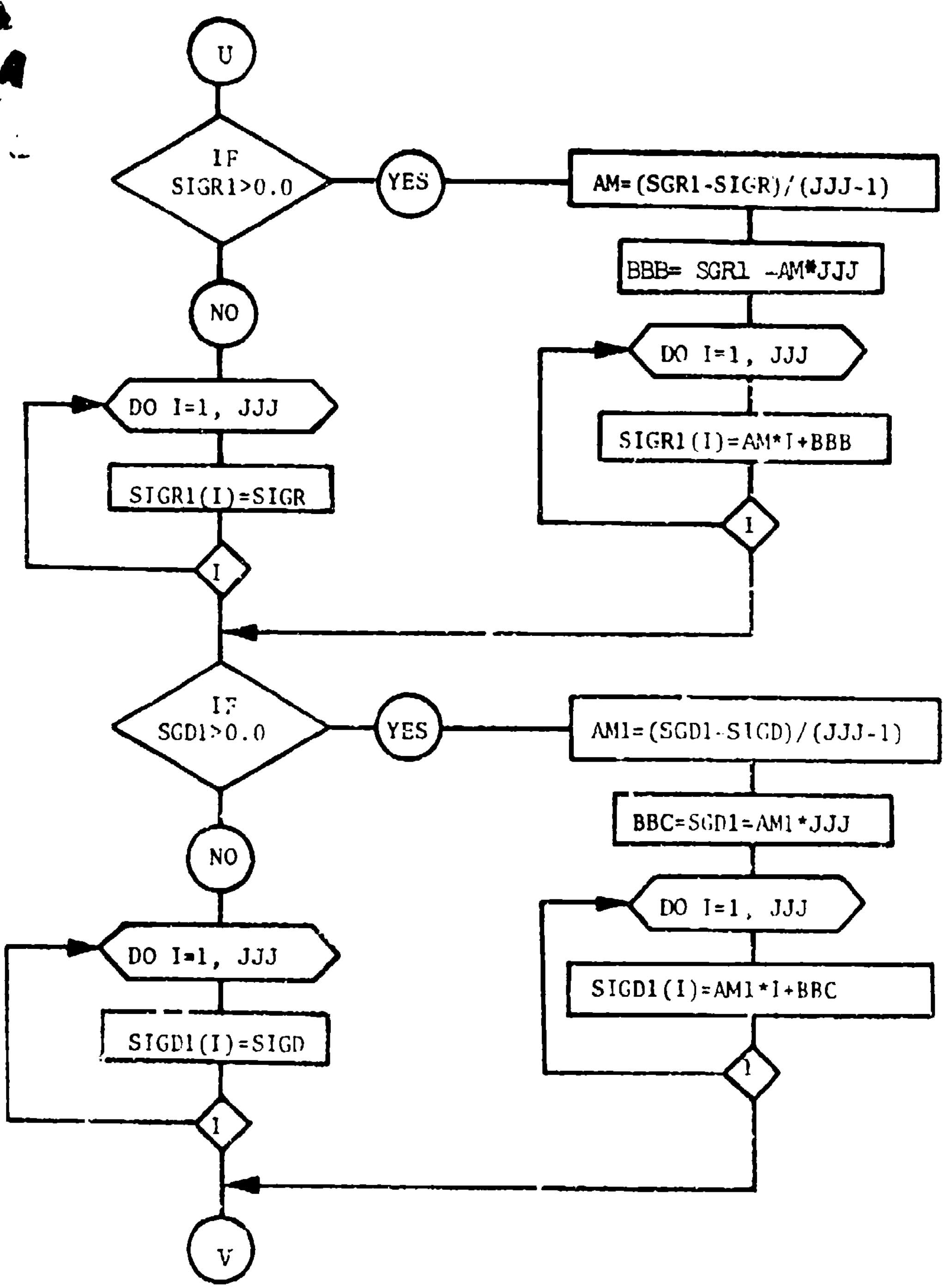

Figure 8. Flow Chart of Overlay 1,0 (Continued)

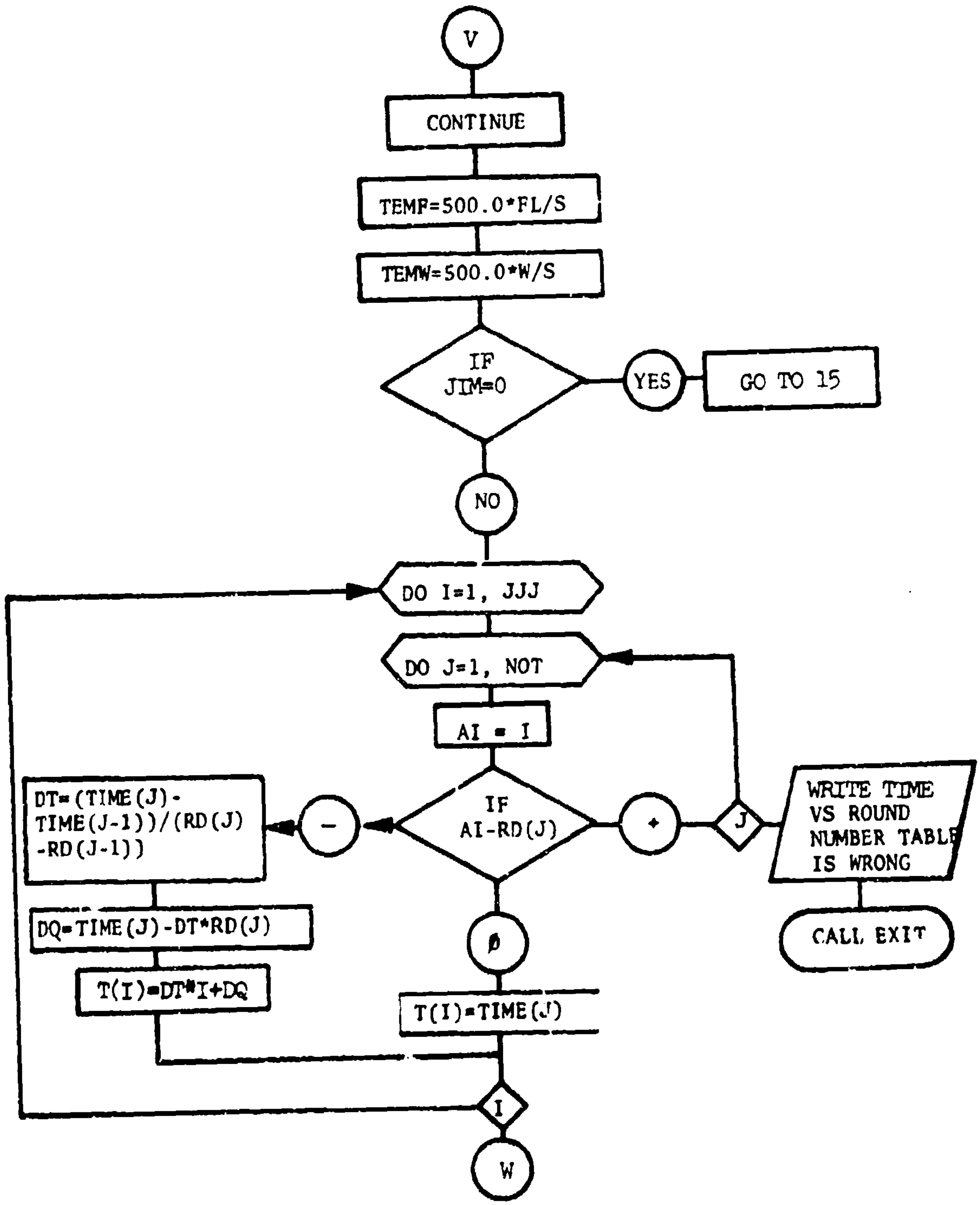

Figure 8. Flow Chart of Overlay 1,0 (Continued)

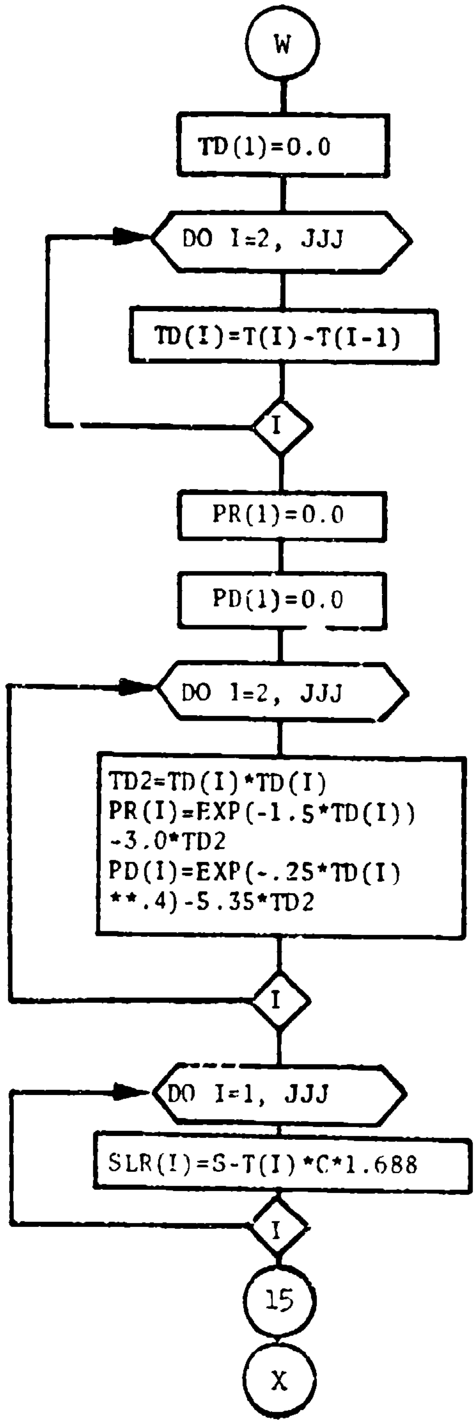

Figure 8. Flow Chart of Overlay 1,0 (Continued)

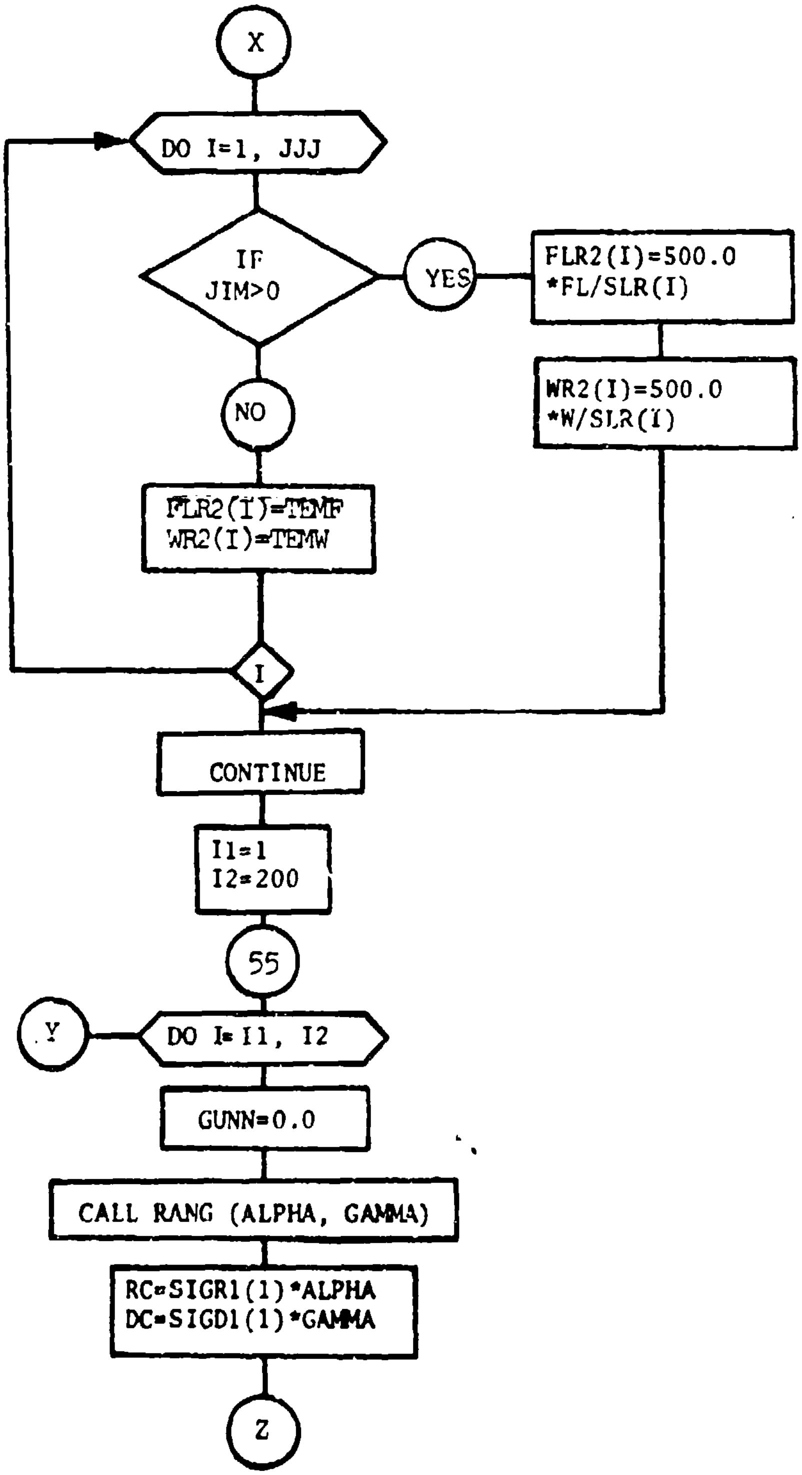

Figure 8. Flow Chart of Overlay 1,0 (Continued)

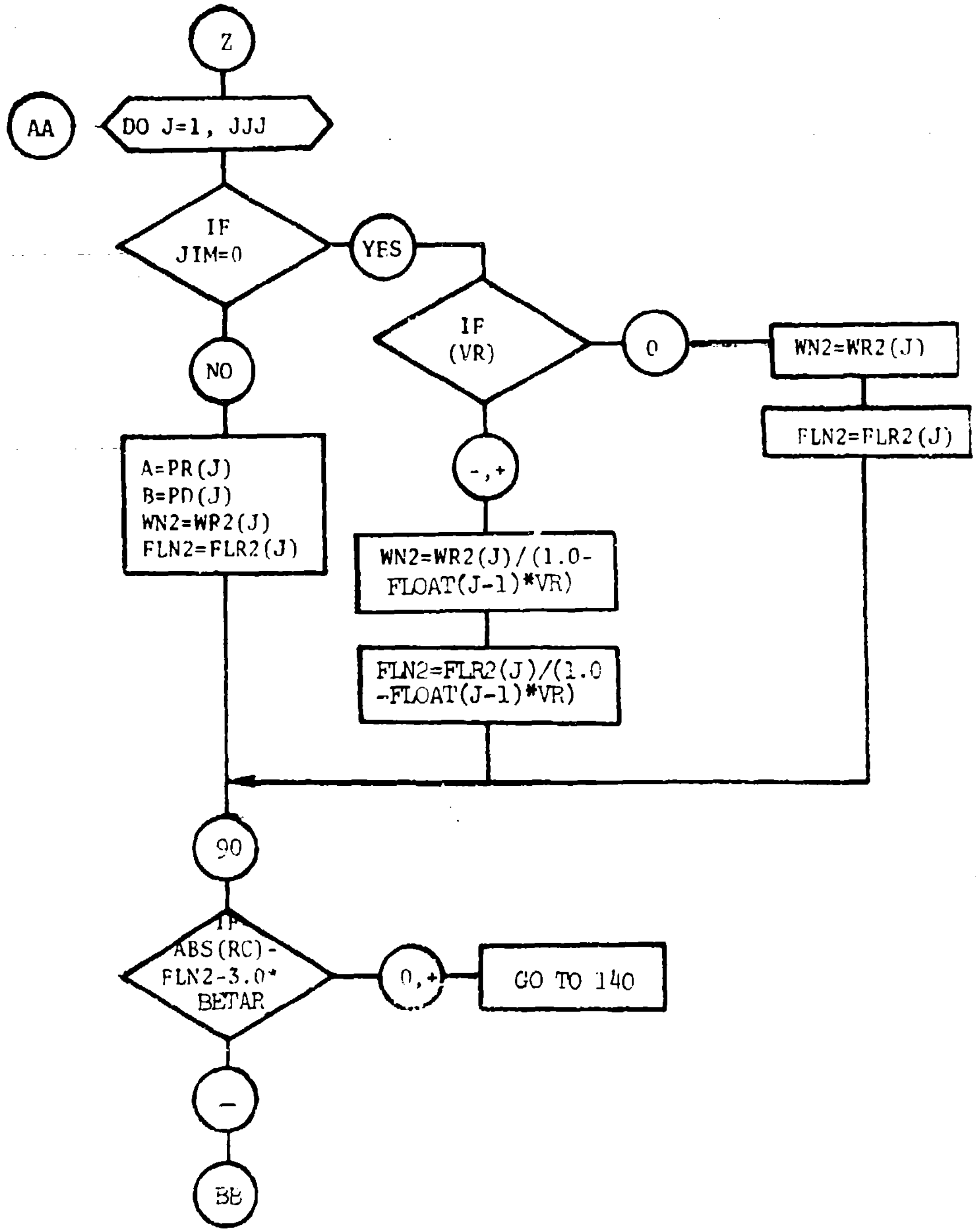

Figure 8. Flow Chart of Overlay 1,0 (Continued)

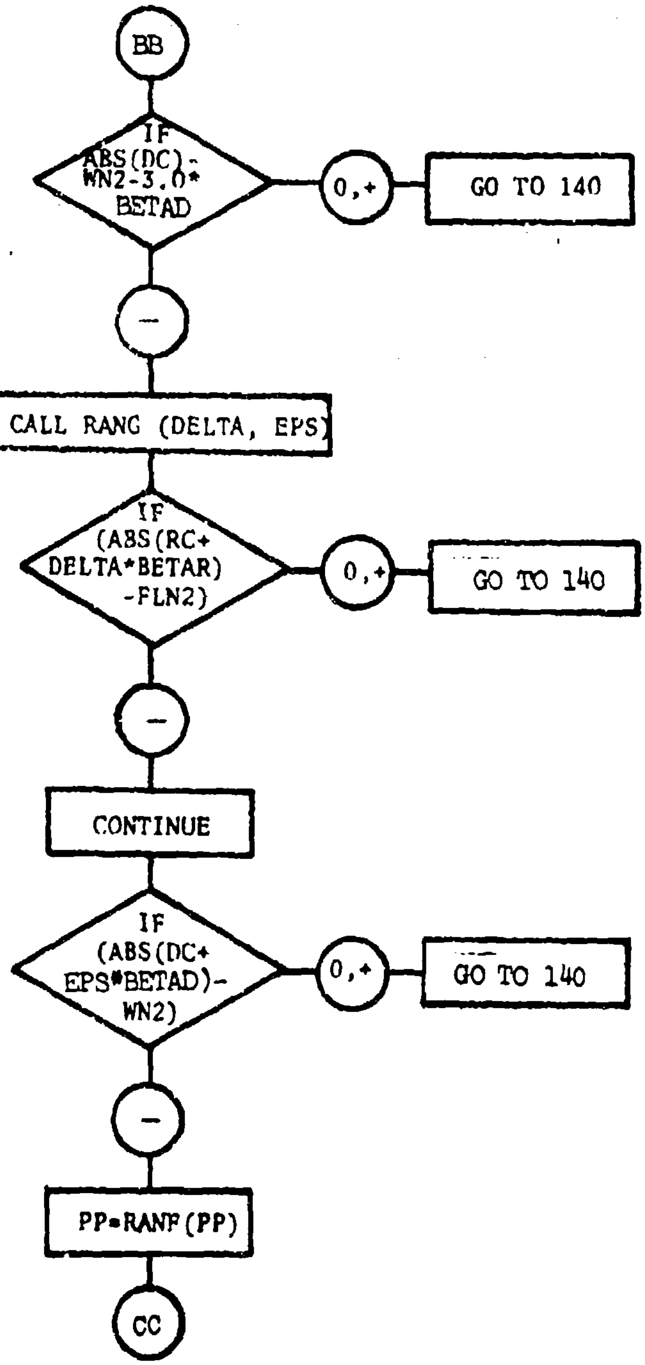

Figure 8. Flow Chart of Overlay 1,0 (Continued)

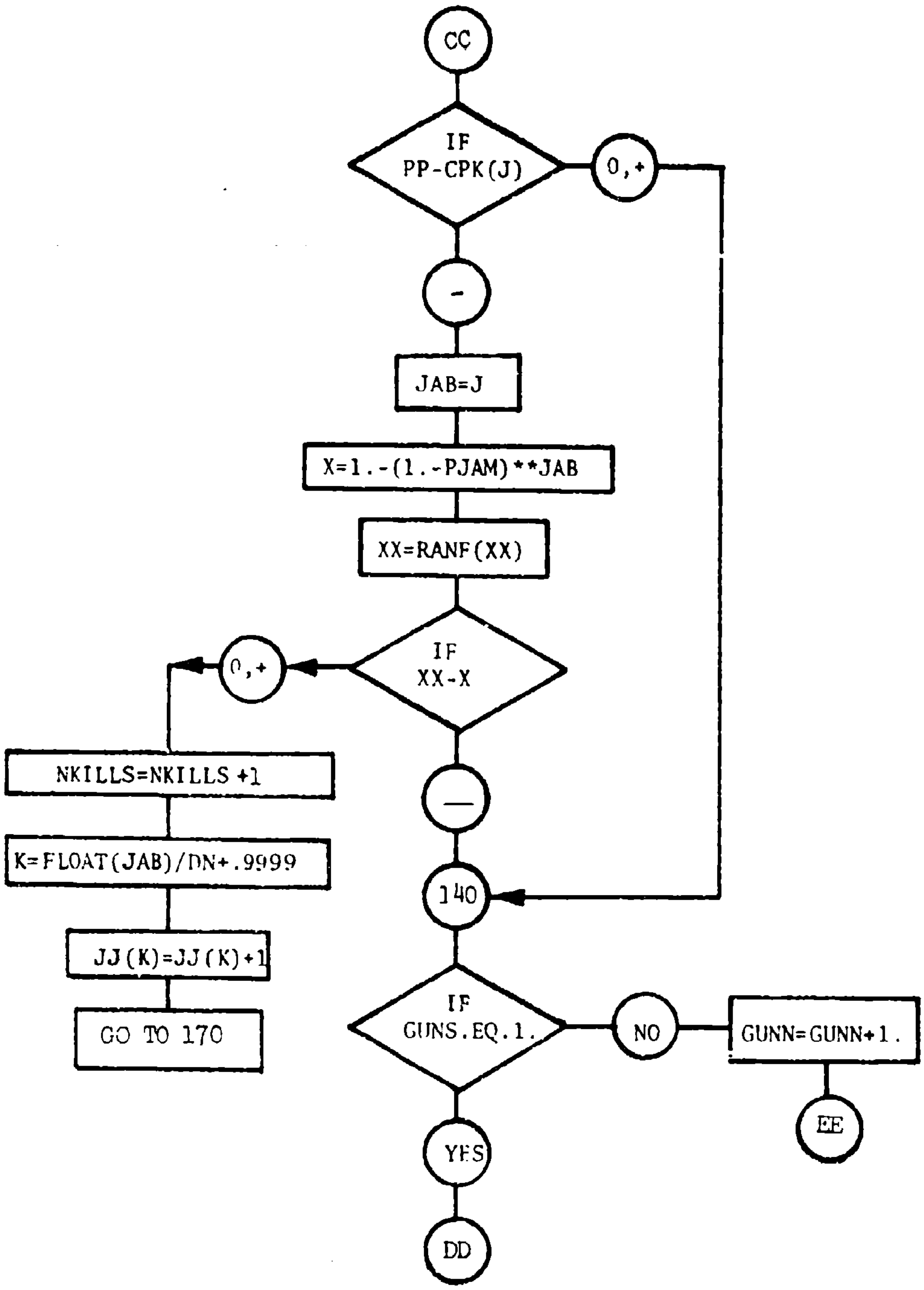

Figure 8. Flow Chart of Overlay 1,0 (Continued)

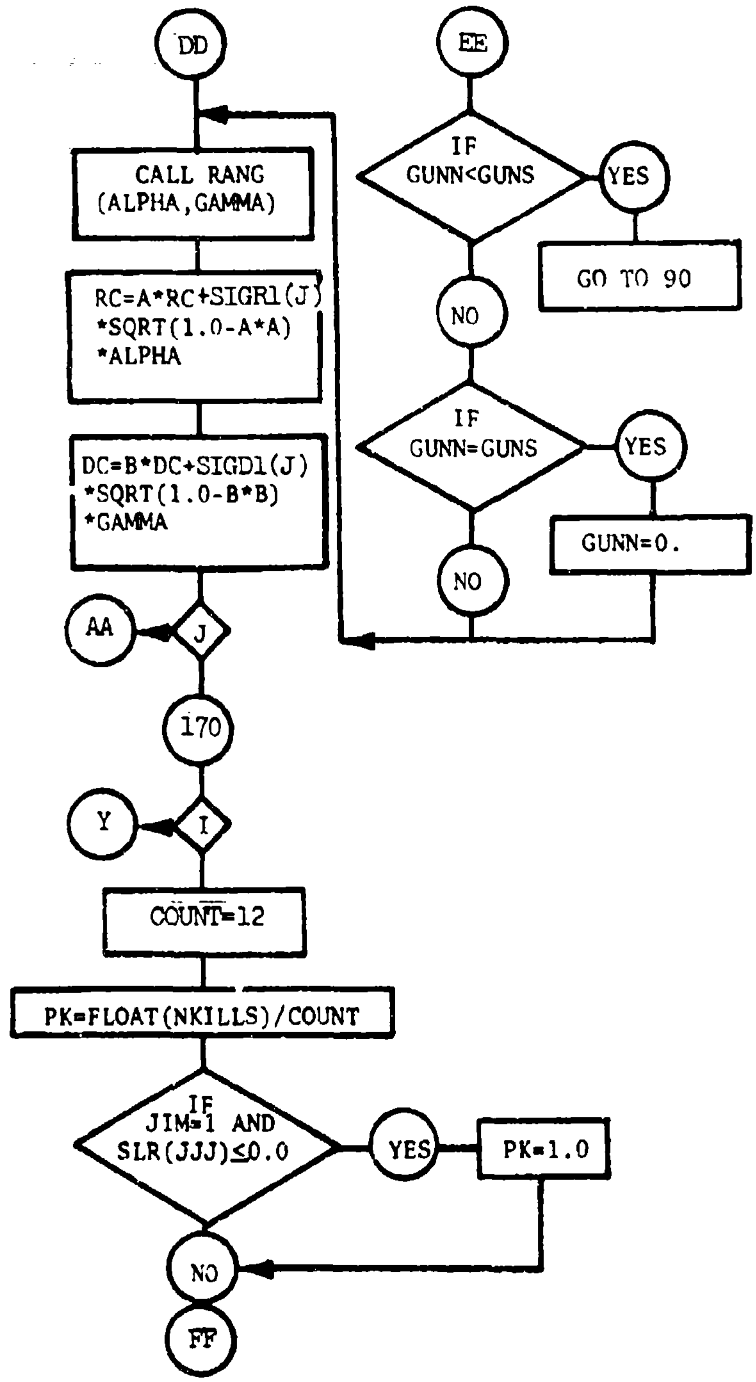

Figure 8. Flow Chart of Overlay 1,0 (Continued)

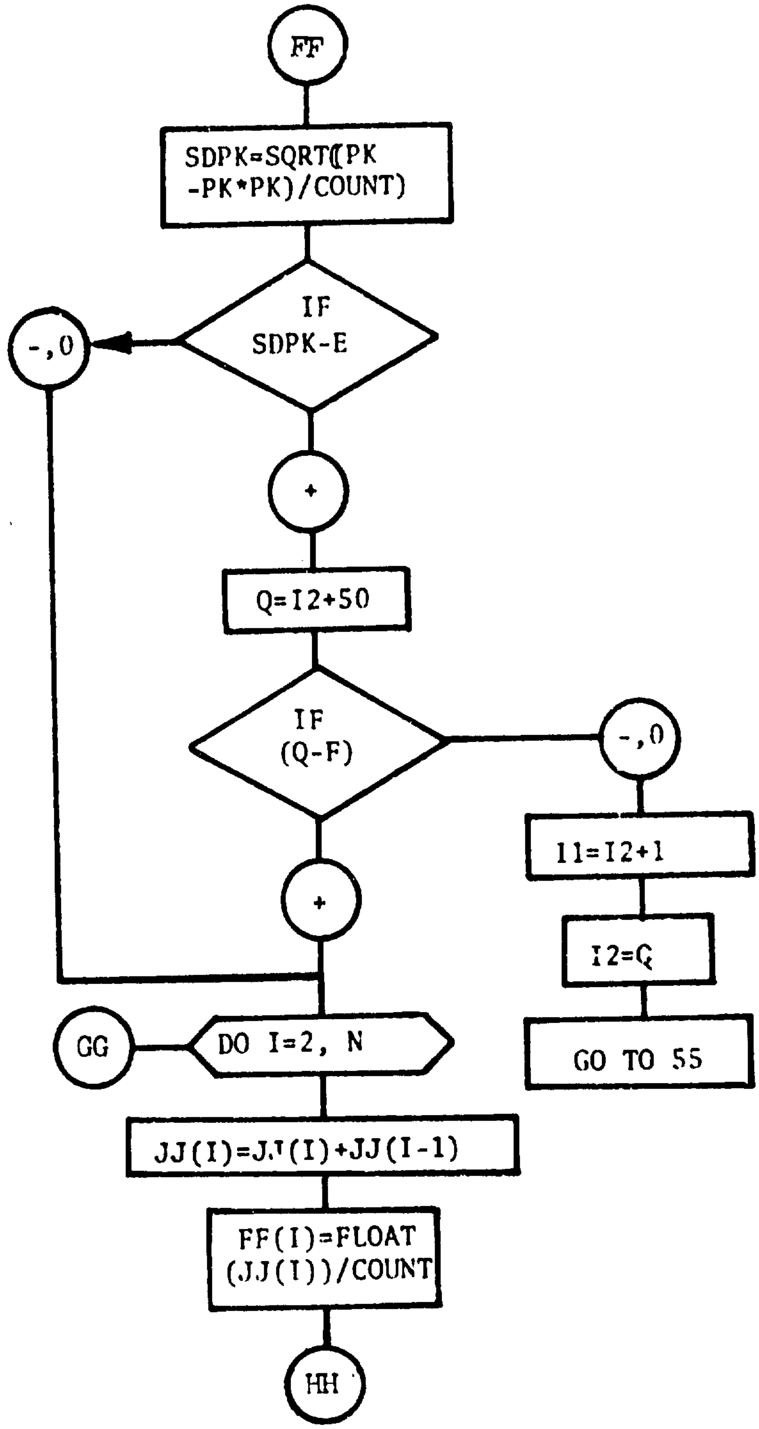

Figure 8. Flow Chart of Overlay 1,0 (Continued)

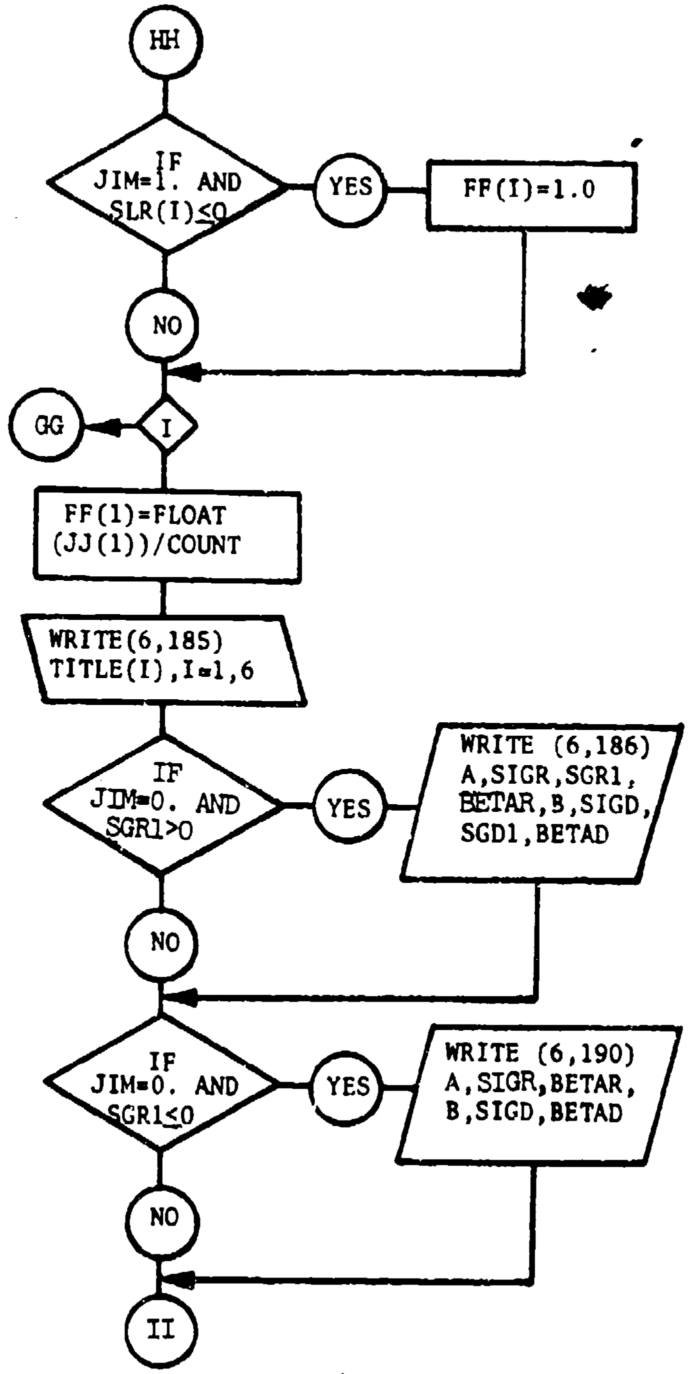

Figure 8. Flow Chart of Overlay 1,0 (Continued)

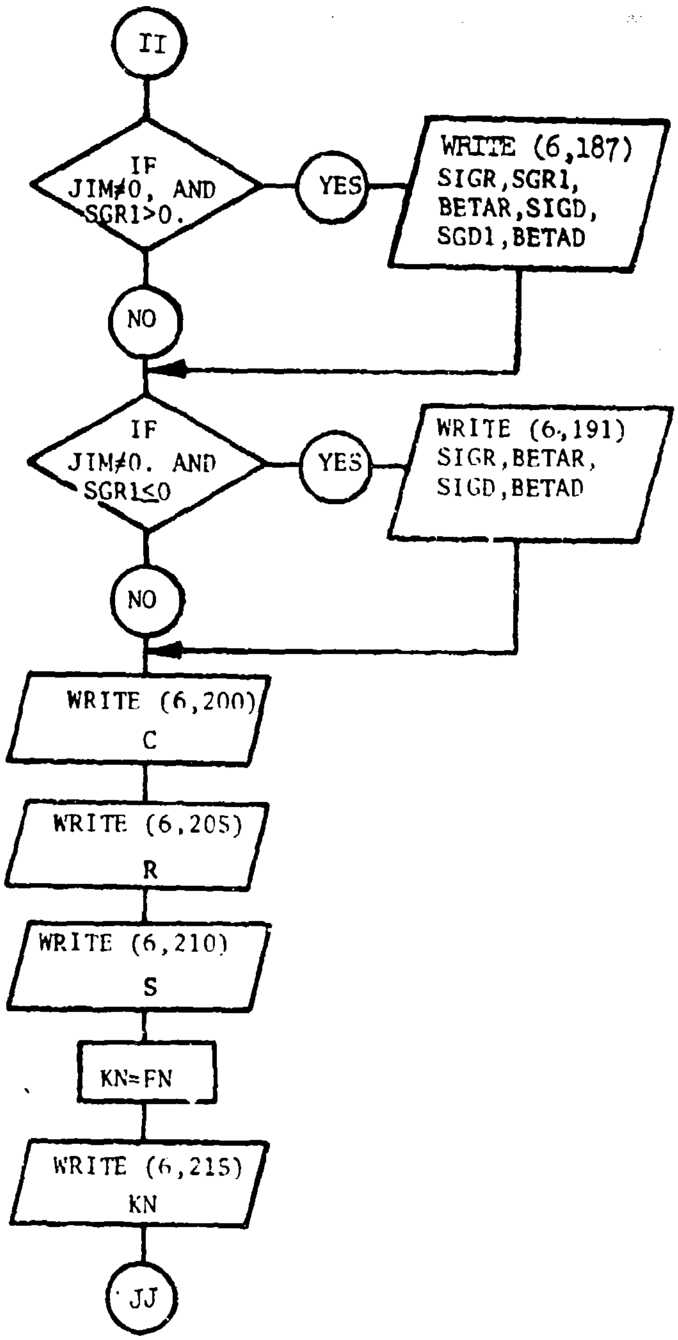

Figure 8. Flow Chart of Overlay 1,0 (Continued)

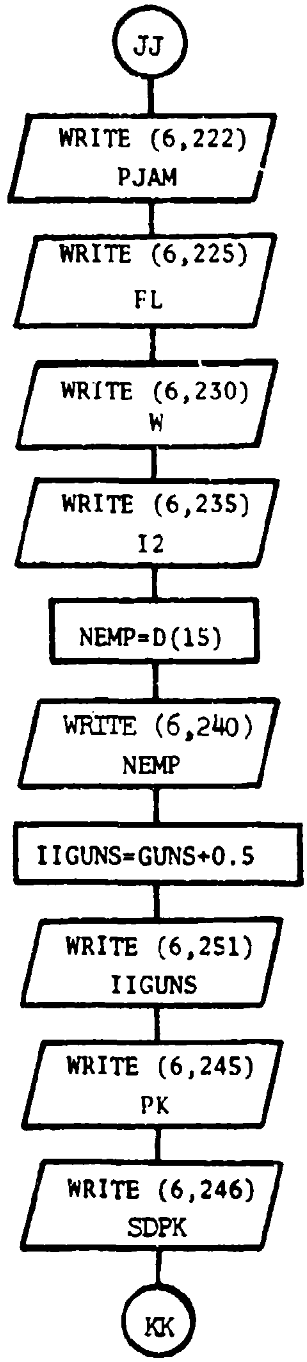

Figure 8. Flow Chart of Overlay 1,0 (Continued)

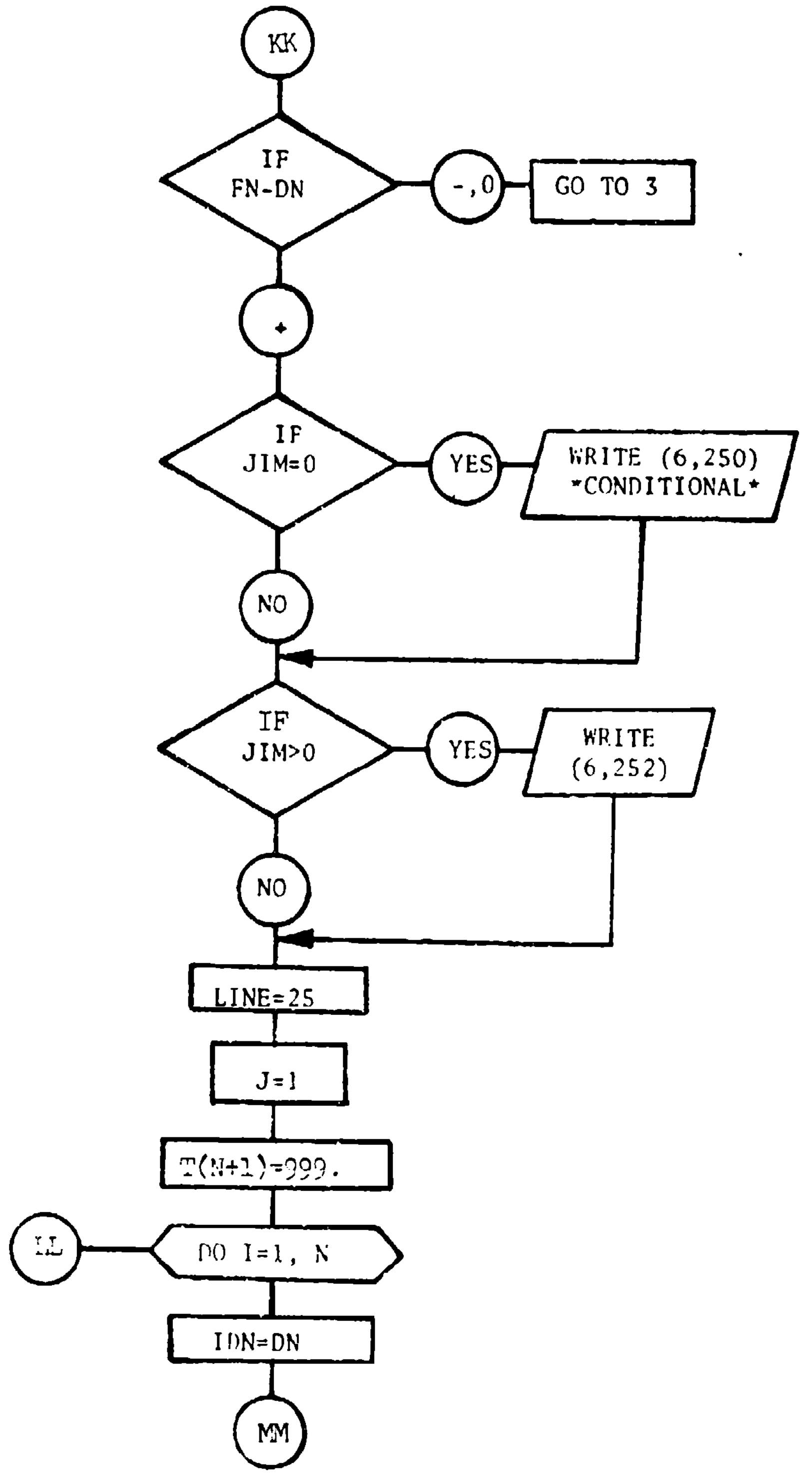

Figure 8. Flow Chart of Overlay 1,0 (Continued)

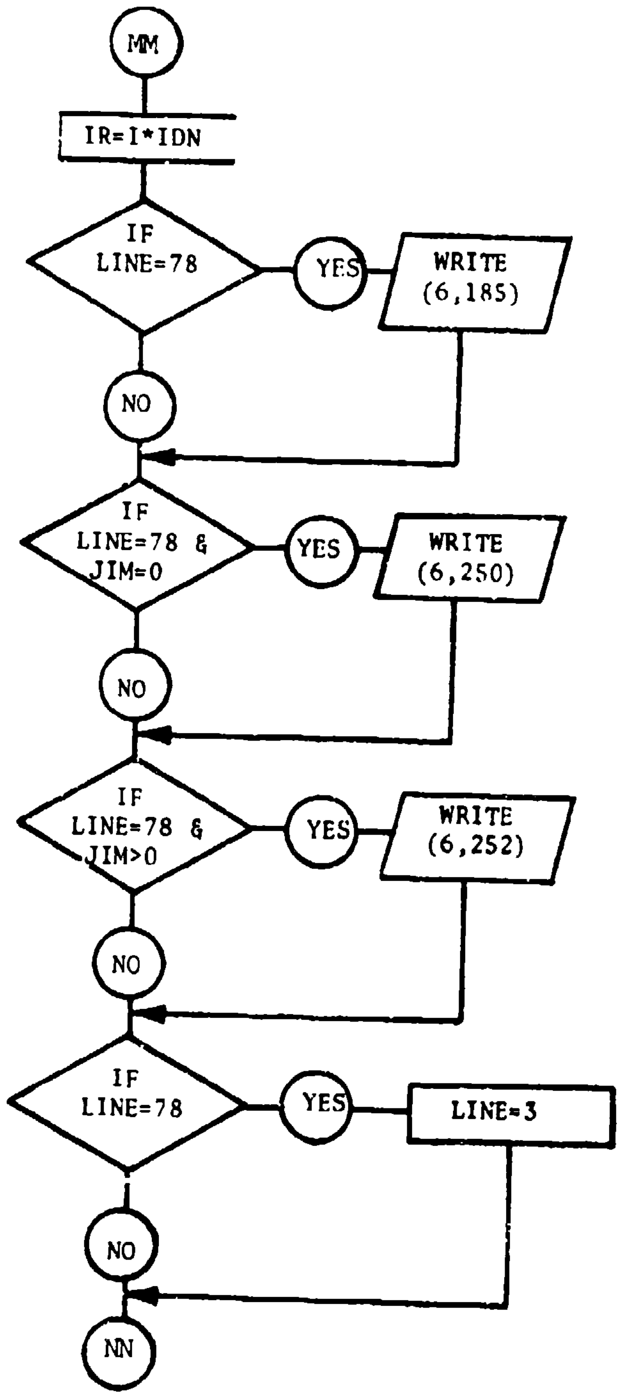

Figure 8. Flow Chart of Overlay 1,0 (Continued)

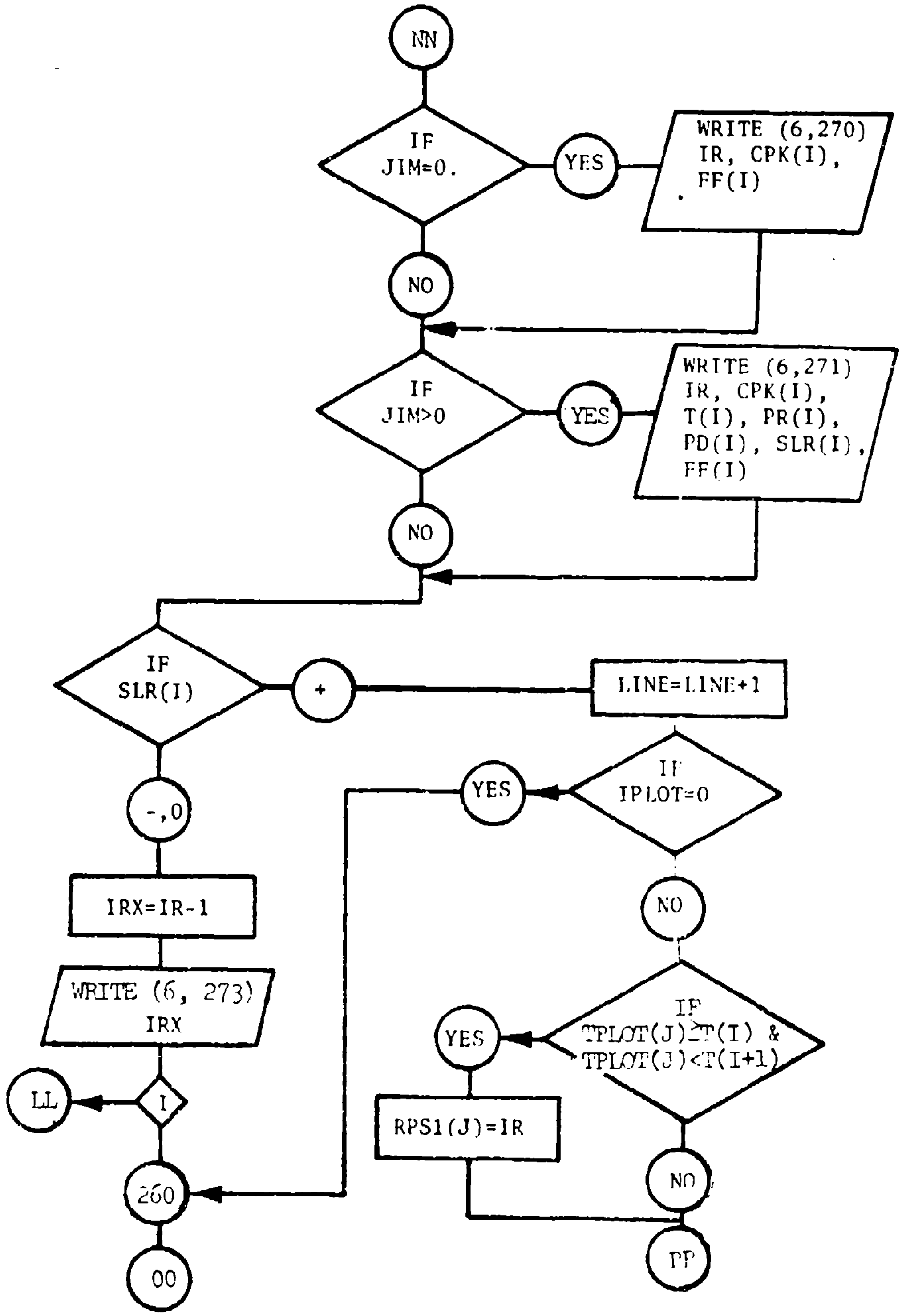

Figure 8. Flow Chart of Overlay 1,0 (Continued)

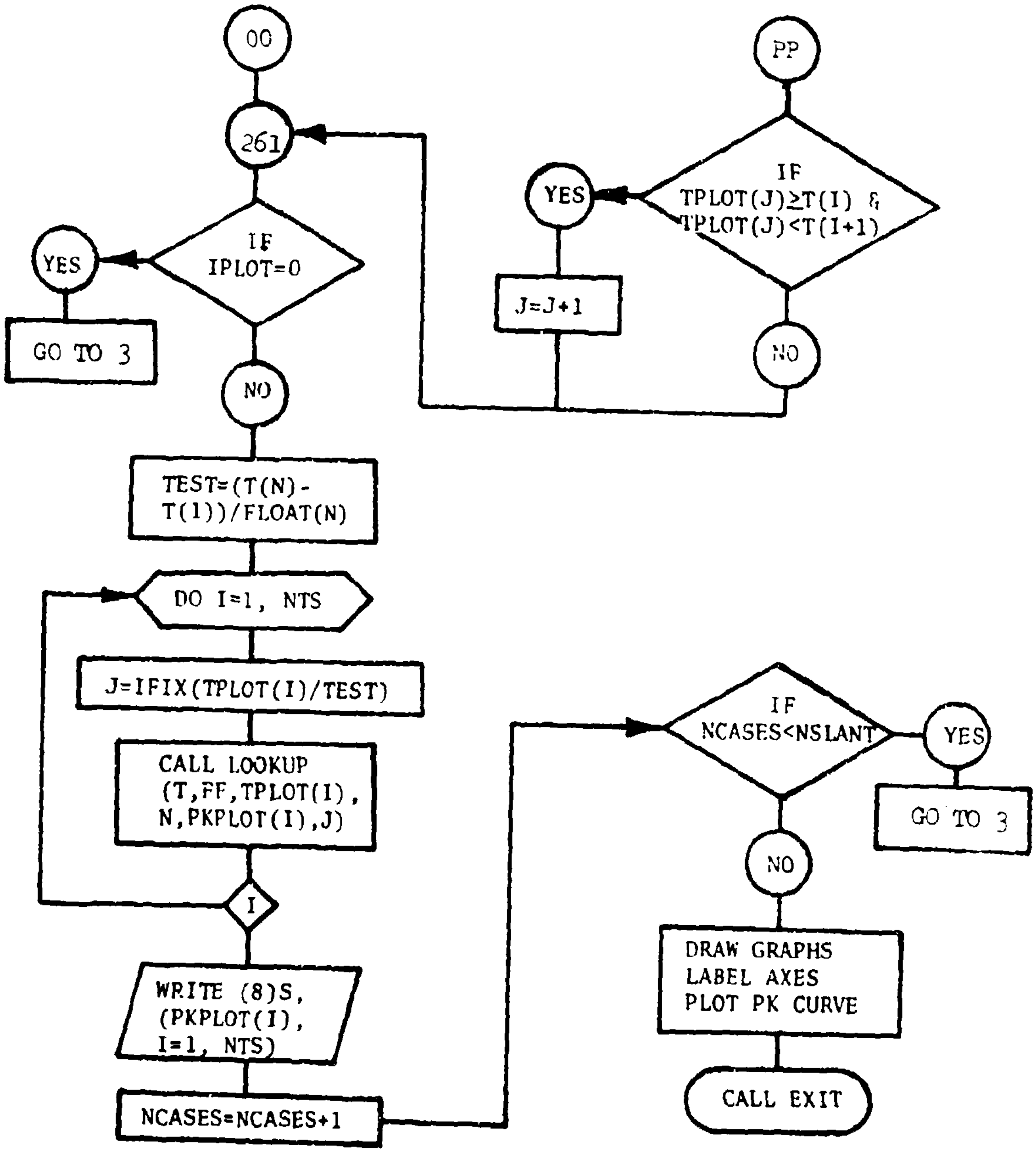

Figure 8. Flow Chart of Overlay 1,0 (Concluded)

APPENDIX C

P0655 PROGRAM LISTING

Appendix C contains a FORTRAN program listing of the air-to-ground gun simulation program complete with three overlays and three subroutines.

PROGRAM P0655   74/74   OPT=1   FTN 4.5+410   22/07/76 14.32.33   PAGE   1

```
          OVERLAY(AFILE,0,0)                                                      P0655     2
          PROGRAM P0655(INPUT=129,OUTPUT=129,TAPE5=INPUT,TAPE6=OUTPUT,TAPE4=      P0655     3
         1 129,TAPE8,FILMPL=0)                                                    P0655     4
          DIMENSION TPLOT (10)                                                    P0655     5
          COMMON/ENODY/IEOF,ITEST,IGO,JIM,IPLOT,IOPT,NTS,TPLOT                    P0655     6
          ITEST = 1                                                               P0655     7
          CALL FORCEV                                                             P0655     8
          ASSIGN 100 TO IEOF                                                      P0655     9
          CALL OVERLAY(5LAFILE,1,0,6HRECALL)                                      P0655    10
          CALL OVERLAY(5LAFILE,2,0,6HRECALL)                                      P0655    11
          IF(IGO .EQ. 0) GO TO 100                                                P0655    12
          CALL OVERLAY(5LAFILE,1,0,6HRECALL)                                      P0655    13
      100 CONTINUE                                                                P0655    14
          CALL EXIT                                                               P0655    15
          END                                                                     P0655    16
```

PROGRAM RUN   74/74   OPT=1   FTN 4.5+410   22/07/76 14.32.33   PAGE   1

```
      OVERLAY(AFILE,1,0)
      PROGRAM RUN
C     OEG AIR-TO-GROUND GUNNERY PROGRAM WITH MONTE CARLO J1MM9N7
      DIMENSION D(20),TITLE(6)
      COMMON JJ(1000),FF(1000),SLR(1000),FLR2(1000),WR2(1000),
     1 CPK(1000),TIME(30),RD(30),TD(1000),PR(1000),PD(1000),
     2 T(1000),SIGR1(1000),SIGD1(1000),CPK1(1000),CPK2(1000),CPK3(1000),
     3 CP1(3),CPN(3),NUMR(3)
      DIMENSION TPLOT(10),PKPLOT(10)
      COMMON/ENDDT/IEOF,ITEST,IGO,JIM,IPLOT,IOPT,NTS,TPLOT
      DIMENSION RPS1(10)
      EQUIVALENCE (D(1),A),(D(2),B),(D(3),SIGR),(D(4),SIGD),(D(5),BETAR
     1),(D(6),BETAD),(D(7),S),(D(8),R),(D(9),C),(D(10),FN),(D(11),P),
     2(D(12),FL),(D(13),W),(D(14),F),(D(16),DN),(D(17),E),(D(18),PJAM)
     3,(D(19), GUNS)
      EXTERNAL TABL1V
      DATA TARG4 /5HT4    /
      CALL PLTIDV
      GO TO (600,  8),ITEST
  600 CALL REPRNT
      ASSIGN 400 TO IEOF
      JIM = 0
      DO 605 I = 1,10
      TPLOT(I)=0.0
  605 PKPLOT(I)=0.0
    1 FORMAT(6A10,F10.0)
    2 FORMAT(I2,F8.0,F10.0)
    4 FORMAT(3I1,I2,10F7.0)
      READ(4,4)IPLOT,IOPT,IGO,NTS,(TPLOT(I),I=1,NTS)
      IF(EOF(4).NE.0.0)  GO TO 400
      IF(IOPT .EQ. 1 .AND. IPLOT .GT. 1) GO  TO 405
      IF(IOPT .NE. 1) GO TO 8
      ITEST = 2
      GO TO 511
    8 ASSIGN 400 TO IEOF
      IF(IPLOT .EQ. 0) GO TO 3
      IF(IPLOT.EQ.2) GO TO 1000
   12 FORMAT(I5)
   11 READ(4,12) NSLANT
      IF(EOF(4).NE.0.0)  GO TO 400
      NCASES = C
    3 READ(4,1) (TITLE(K),K=1,6),DIVE
      IF(EOF(4).NE.0.0)  GO TO 400
    5 READ(4,2) L,PRMTR,PM2
      IF(EOF(4).NE.0.0)  GO TO 400
      IF(L.EQ.20) GO TO 20
      IF (L) 7,7,6
    6 D(L) = PRMTR
      IF(L.NE.11) GO TO 28
      NTYPE = PRMTR
      DO 25 I=1,NTYPE
   25 READ(4,27) NUMR(I),CP1(I),CPN(I)
      IF(EOF(4).NE.0.0)  GO TO 400
   27 FORMAT(I5,2F10.0)
   28 IF(L.EQ.3) SGR1 = PM2
      IF(L.EQ.4) SGD1 = PM2
      GO TO 5
   20 JIM = PRMTR
      IF(JIM.NE.1) GO TO 5
      READ(4,9) NOT,(RD(I),I=1,NOT)
      IF(EOF(4).NE.0.0)  GO TO 400
      READ(4,10) (TIME(I),I=1,NOT)
      IF(EOF(4).NE.0.0)  GO TO 400
      DO 44 I=1,NOT
   44 IF(TIME(I).EQ.1.0) RPS=RD(I)
```

```
    9 FORMAT(I5/(10F8.2))                                                P0655      82
   10 FORMAT(16F5.4)                                                     P0655      83
      GO TO 5                                                            P0655      84
    7 II = D(15)                                                         P0655      85
      DO 45 I=1,II                                                       P0655      86
   45 CALL RANG(DUMMY,DUMMY)                                             P065501     2
      V = 1.688*C                                                        P0655      89
      VR = 68.8*V/(S*R)                                                  P0655      90
      N = FN/DN                                                          P0655      91
      DO 50 I=1,N                                                        P0655      92
   50 JJ(I) = 0                                                          P0655      93
      NKILLS = 0                                                         P0655      94
      JJJ = FN                                                           P0655      95
      IF(NTYPE.EQ.1.AND.NUMR(1).LE.0) NUMR(1) = JJJ                      P0655      96
C  COMPUTE ARRAY OF CONDITIONAL KILL PROBABILITY                         P0655      97
      DO 550 I=1,JJJ                                                     P0655      98
      T(I)=0.0                                                           P0655      99
      FF(I)=0.0                                                          P0655     100
      SLR(I)=0.0                                                         P0655     101
      CPK1(I) = 0.0                                                      P0655     102
      CPK2(I) = 0.0                                                      P0655     103
  550 CPK3(I) = 0.0                                                      P0655     104
      DO 490 J=1,NTYPE                                                   P0655     105
      IF(CPN (J).GT.0.0) GO TO 493                                       P0655     106
      DO 491 I=1,JJJ                                                     P0655     107
      IF(J.EQ.1) CPK1(I) = CP1(J)                                        P0655     108
      IF(J.EQ.2) CPK2(I) = CP1(J)                                        P0655     109
  491 IF(J.EQ.3) CPK3(I) = CP1(J)                                        P0655     110
      GO TO 490                                                          P0655     111
  493 CONTINUE                                                           P0655     112
      JSTR = 1                                                           P0655     113
      IST = 2                                                            P0655     114
      DO 580 IV = 3,NOT                                                  P0655     115
      IF(IV .GT. 3) JSTR = JSTP                                          P0655     116
      IST = IST + 1                                                      P0655     117
      BBB= CP1(J) +   (CPN(J)-CP1(J))*(TIME(IST-1)/TIME(NOT))            P0655     118
      IF(IV .GT. 3) BBB = TEMP                                           P0655     119
      AN = (TIME(IST)-TIME(IST-1))*(CPN(J)-CP1(J))/((RD(IST)-RD'IST-1))  P0655     120
     1*TPLOT(NTS))                                                       P0655     121
      JSTP = RD(IST)                                                     P0655     122
      DO 494 I = JSTR,JSTP                                               P0655     123
      TEMP = AN*(I-JSTR)+BBB                                             P0655     124
      IF(J.EQ.1) CPK1(I) = TEMP                                          P0655     125
      IF(J.EQ.2) CPK2(I) = TEMP                                          P0655     126
  494 IF(J.EQ.3) CPK3(I) = TEMP                                          P0655     127
  580 CONTINUE                                                           P0655     128
  490 CONTINUE                                                           P0655     129
      IN = 1                                                             P0655     130
      INC = NUMR(1)                                                      P0655     131
      LST = INC                                                          P0655     132
  495 IF(INC.GT.JJJ) INC = JJJ                                           P0655     133
      DO 496 I=IN,INC                                                    P0655     134
  496 CPK(I) = CPK1(I)                                                   P0655     135
      IF(INC.EQ.JJJ) GO TO 501                                           P0655     136
      IF(NTYPE.EQ.1) GO TO 500                                           P0655     137
      IST = INC+NUMR(2)                                                  P0655     138
      IS = INC+1                                                         P0655     139
      LST = IST                                                          P0655     140
      IF(IST.GT.JJJ) IST = JJJ                                           P0655     141
      DO 497 I=IS,IST                                                    P0655     142
  497 CPK(I) = CPK2(I)                                                   P0655     143
      IF(IST.EQ.JJJ) GO TO 501                                           P0655     144
      IF(NTYPE.EQ.2) GO TO 500                                           P0655     145
      LST =IST+NUMR(3)                                                   P0655     146
      LS =IST+1                                                          P0655     147
```

```
      IF(LST.GT.JJJ) LST = JJJ
      DO 498 I=LS,LST
  498 CPK(I) = CPK3(I)
      IF(LST.EQ.JJJ) GO TO 501
  500 INC =LST+NUMP(1)
      IN = LST+1
      IF(IN.LE.JJJ) GO TO 495
  501 CONTINUE
C  COMPUTE ARRAY OF AIMING ERRORS
      IF(SGR1.GT.0.0) GO TO 503
      DO 504 I=1,JJJ
  504 SIGR1(I) = SIGR
      GO TO 505
  503 AM = (SGR1-SIGR)/(JJJ-1)
      BBB = SGR1-AM*JJJ
      DO 26 I=1,JJJ
   26 SIGR1(I) = AM*I+BBB
  505 IF(SGO1.GT.0.0) GO TO 506
      DO 507 I=1,JJJ
  507 SIGO1(I) = SIGO
      GO TO 508
  506 AM1 = (SGO1-SIGO)/(JJJ-1)
      BBC = SGO1-AM1*JJJ
      DO 509 I=1,JJJ
  509 SIGO1(I) = AM1*I+BBC
  508 CONTINUE
      TEMF= 500.0*FL/S
      TEMW = 500.0*W/S
      IF(JIM.EQ.0) GO TO 15
       DO 75 I=1,JJJ
      DO 71 J=1,NOT
      AI = I
      IF(AI-RD(J)) 73,72,71
   71 CONTINUE
      WRITE(6,76)
   76 FORMAT(1X,*TIME VS ROUND NUMBER TABLE IS WRONG*)
      CALL EXIT
   72 T(I) = TIME(J)
      GO TO 75
   73 DT = (TIME(J)-TIME(J-1))/( RD(J)- RD(J-1))
      DQ = TIME(J)-DT* RD(J)
      T(I) = DT*I+DQ
   75 CONTINUE
      TD(1) = 0.
      DO 65 I=2,JJJ
   65 TD(I) = T(I)-T(I-1)
      PR(1) = 0.
      PD(1) = 0.
      DO 68 I=2,JJJ
      TD2 = TD(I)**2
      PR(I) = EXP(-1.5*TD(I))-3.*TD2
   68 PD(I) = EXP(-.25*TD(I)**.4)-5.35*TD2
      DO 14 I=1,JJJ
   14 SLR(I) = S-T(I)*C*1.688
   15 DO 22 I=1,JJJ
      IF(JIM.GT.0) GO TO 24
      FLR2(I) = TEMF
      WR2(I)= TEMW
      GO TO 22
   24 FLR2(I)= 500.0*FL/SLR(I)
      WR2(I) = 500.0*W/SLR(I)
   22 CONTINUE
      I1 = 1
      I2 = 200
   55 DO 170 I=I1,I2
```

```
      GUNN = 0.                                                        P0655     213
      CALL RANG(ALPHA,GAMMA)                                           P065501     3
      RC = SIGR1(1)*ALPHA                                              P0655     216
      DC = SIGD1(1)*GAMMA                                              P0655     217
      DO 150 J=1,JJJ                                                   P0655     218
      IF(JIM.EQ.0) GO TO 60                                            P0655     219
      A = PR(J)                                                        P0655     220
      B = PD(J)                                                        P0655     221
      WN2=WR2(J)                                                       P0655     222
      FLN2 = FLR2(J)                                                   P0655     223
      GO TO 90                                                         P0655     224
   60 IF (VR) 80,70,80                                                 P0655     225
   70 WN2=WR2(J)                                                       P0655     226
      FLN2=FLR2(J)                                                     P0655     227
      GO TO 90                                                         P0655     228
   80 WN2=WR2(J)/(1.0-FLOAT(J-1)*VR    )                               P0655     229
      FLN2=FLR2(J)/(1.0-FLOAT(J-1)*VR    )                             P0655     230
   90 IF (ABS (RC) - FLN2 - 3.0*BETAR) 100,140,140                     P0655     231
  100 IF (ABS (DC) - WN2 - 3.0*BETAD) 110,140,140                      P0655     232
  110 CALL RANG(DELTA,EPS)                                             P065501     4
      IF (ABS (RC+DELTA*BETAR) - FLN2) 120,140,140                     P0655     234
  120 CONTINUE                                                         P065501     5
      IF (ABS (DC+EPS*BETAD) - WN2) 130,140,140                        P0655     236
  130 PP = RANF(PP)                                                    P065501     6
      IF(PP-CPK(J)) 132,140,140                                        P0655     238
  132 JAB = J                                                          P0655     239
      X = 1. - (1. - PJAM)**JAB                                        P0655     240
      XX = RANF(XX)                                                    P065501     7
      IF (XX - X) 140,160,160                                          P0655     242
  140 IF(GUNS.EQ.1) GO TO 145                                          P0655     243
C                                                                      P0655     244
C  MULTIPLE GUNS                                                       P0655     245
C                                                                      P0655     246
      GUNN = GUNN+1.                                                   P0655     247
      IF(GUNN.LT.GUNS) GO TO 90                                        P0655     248
      IF(GUNN.EQ.GUNS) GUNN = 0.                                       P0655     249
  145 CALL RANG(ALPHA,GAMMA)                                           P065501     8
      RC = A*RC+SIGR1(J)*SQRT(1.0-A**2)*ALPHA                          P0655     252
      DC = B*DC+SIGD1(J)*SQRT(1.0-B**2)*GAMMA                          P0655     253
  150 CONTINUE                                                         P0655     254
      GO TO 170                                                        P0655     255
  160 NKILLS = NKILLS + 1                                              P0655     256
      K = FLOAT (JAB)/DN + 0.9999                                      P0655     257
      JJ(K) = JJ(K) + 1                                                P0655     258
  170 CONTINUE                                                         P0655     259
      COUNT = I2                                                       P0655     260
      PK = FLOAT (NKILLS)/COUNT                                        P0655     261
      IF(JIM.EQ.1.AND.SLR(JJJ).LE.0.0) PK = 1.0                        P0655     262
      SDPK = SQRT ((PK - PK*PK)/COUNT)                                 P0655     263
      IF (SDPK - E) 175,175,173                                        P0655     264
  173 Q = I2 + 56                                                      P0655     265
      IF (Q - F) 174,174,175                                           P0655     266
  174 I1 = I2 + 1                                                      P0655     267
      I2 = Q                                                           P0655     268
      GO TO 55                                                         P0655     269
  175 DO 180 I=2,N                                                     P0655     270
      JJ(I) = JJ(I) + JJ(I-1)                                          P0655     271
      FF(I) = FLOAT(JJ(I))/COUNT                                       P0655     272
  180 IF(JIM.EQ.1.AND.SLR(I).LE.0.0) FF(I) = 1.0                       P0655     273
      FF(1) = FLOAT (JJ(1))/COUNT                                      P0655     274
      WRITE(6,185) (TITLE(I),I=1,6)                                    P0655     275
  185 FORMAT(1H1,34X,6A10)                                             P0655     276
      IF(JIM.EQ.0.AND.SGR1.GT.0.0) WRITE(6,186) A,SIGR,SGR1,BETAR,B,   P0655     277
     1 SIGD,SGD1,BETAD                                                 P0655     278
      IF(JIM.EQ.0.AND.SGR1.LE.0.0) WRITE(6,190)A,SIGR,BETAR,B,SIGD,BETAD P0655   279
```

```
      IF(JIM.NE.0.AND.SSR1.GT.0.0) WRITE(6,187) SIGR,SSR1,BETAR,SIGO,
     1 SSR1,BETAO
      IF(JIM.NE.0.AND.SSR1.LE.0.0)WRITE(6,191)SIGR,BETAR,SIGO,BETAO
  187 FORMAT(/49X,9HAIM ERROR,4X,9HBALLISTIC/33X,10HCOORDINATE,7X,6H(MIL
     1S)4X,17HDISPERSION (MILS)//34X,5HRANGE,4X,F5.1,2X,F5.1,7X,F5.1,/
     134X,10HDEFLECTION,3X,F5.1,2X,F5.1,7X,F5.1)
  185 FORMAT(/49X,11HCORRELATION,6X,9HAIM ERROR,4X,9HBALLISTIC/33X,
     1 10HCOORDINATE,7X,9HCONSTANTS,8X,6H(MILS),4X,17HDISPERSION (MILS)/
     1/34X,5HRANGE,13X,F5.3,5X,F5.1,2X,F5.1,7X,F5.1,/34X,10HDEFLECTION,
     29X,F5.3,5X,F5.1,2X,F5.1,7X,F5.1)
  191 FORMAT(/49X,9HAIM ERROR,4X,9HBALLISTIC/33X,10HCOORDINATE,7X,6H(MIL
     1S)4X,17HDISPERSION (MILS)//34X,5HRANGE,13X,F5.1,9X,F5.1,/34X,
     210HDEFLECTION,8X,F5.1,9X,F5.1)
  190 FORMAT (/49X, 11HCORRELATION, 6X, 9HAIM ERROR, 4X, 9HBALLISTIC
     1/33X, 10HCOORDINATE, 7X, 9HCONSTANTS, 8X, 6H(MILS), 4X, 17HDISPERS
     2ION (MILS)//34X, 5HRANGE, 13X, F5.3, 10X, F5.1, 9X, F5.1/34X, 10HD
     3EFLECTION, 9X, F5.3, 10X, F5.1, 9X, F5.1)
      WRITE(6,200) C
  200 FORMAT (/34X, 24H AIRCRAFT SPEED (KTAS) =, F6.0)
      WRITE(6,205) R
  205 FORMAT(35X,*STEADY STATE FIRING RATE PER GUN (RDS/MIN) =*,F6.0)
      WRITE(6,210) S
  210 FORMAT (34X, 49H SLANT RANGE AT COMMENCEMENT OF FIRING RUN (FT) =,
     1F7.0)
      KN = FN
      WRITE(6,215) KN
  215 FORMAT(35X,*NO. OF ROUNDS PER PASS PER GUN = *,I6)
      WRITE(6,222) PJAM
  222 FORMAT (34X, 26H PROBABILITY OF JAMMING = , F8.5)
      WRITE(6,225) FL
  225 FORMAT (/34X, 23H TARGET LENGTH (FEET) =,F7.1)
      WRITE(6,230) W
  230 FORMAT (34X, 23H TARGET WIDTH (FEET)  =,F7.1)
      WRITE(6,235) I2
  235 FORMAT (/34X, 35H NUMBER OF MONTE CARLO ITERATIONS =,I6)
      NEMP = D(15)
      WRITE(6,240) NEMP
  240 FORMAT (34X, 55H NUMBER OF EMPTY PASSES THROUGH RANDOM NO. GENERAT
     1ORS =, I7)
      IIGUNS=GUNS+0.5
      WRITE(6,251)IIGUNS
  251 FORMAT(35X,*NUMBER OF GUN SYSTEMS CONSIDERED = *,I5)
      WRITE(6,245) PK
  245 FORMAT (///34X, 29H PROBABILITY OF TARGET KILL =,F6.3)
      WRITE(6,246) SDPK
  246 FORMAT (34X, 33H STANDARD DEVIATION OF THE MEAN =, F7.4)
      IF (FN - DN) 3,3,248
  248 IF(JIM.EQ.0) WRITE(6,250)
      IF(JIM.GT.0) WRITE(6,252)
  250 FORMAT(///56X,*CONDITIONAL*/58X,5H KILL,16X,4HKILL/30X,17HNO. OF R
     1OUNDS/GUN,9X,11HPROBABILITY,9X,11HPROBABILITY)
  252 FORMAT(///31X,*CONDITIONAL*,15X,*CORRELATION*/20X,*NO. OF*,8X,
     1 *KILL*,20X,*CONSTANTS*,7X,*SLANT*,9X,*KILL*,/19X,*RDS/GUN*,5X,*PR
     2OBABILITY*,5X,*TIME*,5X,*RANGE*,4X,*DEFL*,5X,*RANGE*5X,*PROBABILIT
     3Y*)
      LINE = 25
      J = 1
      T(N+1) = 999.
      DO 260 I=1,N
      ION = DN
      IR = I*ION
      IF(LINE.EQ.78) WRITE(6,185)
      IF(LINE.EQ.78.AND.JIM.EQ.0) WRITE(6,250)
      IF(LINE.EQ.78.AND.JIM.GT.0) WRITE(6,252)
      IF(LINE.EQ.79) LINE = 3
```

```
      IF(JIN.EQ.0) WRITE(6,270)IR,CPK(I),FF(I)                          P0655     345
      IF(JIN.GT.0) WRITE(6,271) IR,CPK(I),T(I),PR(I),PD(I),SLR(I),FF(I) P0655     346
  271 FORMAT(21X,I5,7X,F6.3, 5X,F7.4,4X ,F5.3,3X,F5.3,4X,F8.0,8X,F5.3)  P0655     347
  270 FORMAT(39X,I5,14X,F6.3,15X,F5.3)                                  P0655     348
      IF(SLR(I))272,272,274                                             P065501     9
  272 IRX = IR-1                                                        P065501    10
      WRITE(6,273) IRX                                                  P065501    11
  273 FORMAT(30X,*THE AIRCRAFT FLEW INTO THE TARGET AFTER FIRING*,I5,   P065501    12
     1,*   ROUNDS*)                                                     P065501    13
      GO TO 261                                                         P065501    14
  274 LINE = LINE + 1                                                   P065501    15
      IF(IPLOT.EQ.0) GO TO 260                                          P0655     350
      IF(TPLOT(J).GE.T(I).AND.TPLOT(J).LT.T(I+1)) RPS1(J) = IR          P0655     351
      IF(TPLOT(J).GE.T(I).AND.TPLOT(J).LT.T(I+1)) J = J+1               P0655     352
  260 CONTINUE                                                          P0655     353
  261 IF(IPLOT .EQ. 0) GO TO 3                                          P065501    16
      TEST = (T(N)-T(1))/FLOAT(N)                                       P0655     355
      DO 300 I=1,NTS                                                    P0655     356
      J = IFIX(TPLOT(I)/TEST)                                           P0655     357
      CALL LOOKUP(T,FF,TPLOT(I),N,PKPLOT(I),J)                          P0655     358
  300 CONTINUE                                                          P0655     359
      WRITE (8) S,(PKPLOT(I),I=1,NTS)                                   P0655     360
      NCASES = NCASES+1                                                 P0655     361
      IF(NCASES.LT.NSLANT) GO TO 3                                      P0655     362
C************************************************************************P0655     363
C****                                                               ****P0655     364
C****     THIS SECTION PLOTS PKIS FOR VARIOUS BURST LENGTHS         ****P0655     365
C****     SLANT RANGE AT COMMENCE FIRE IS VARIABLE                  ****P0655     366
C****                                                               ****P0655     367
C************************************************************************P0655     368
  394 FORMAT(F6.3)                                                      P0655     369
  395 FORMAT(F5.0)                                                      P0655     370
  396 FORMAT(F5.2)                                                      P0655     371
  397 FORMAT(F7.1)                                                      P0655     372
      SMAX=AINT((S+2000.0)/1000.0)*1000.0                               P0655     373
C                                                                       P0655     374
C****     DRAW THE GRID, LABEL THE AXES, AND WRITE DESCRIPTIVE          P0655     375
C****       INFORMATION AT THE TOP OF THE FRAME.                        P0655     376
      CALL SETMIV(75,35,65,83)                                          P0655     377
  398 CALL CHSIZV(2,2)                                                  P0655     378
      CALL RITSTV(13,19,TABL1V)                                         P0655     379
      CALL GRID1V(3,0.0,SMAX,0.0,1.0,500.0,0.02,2,5,2,5,6,4)            P0655     380
      CALL RITE2V(126,1009,1023,90,1,22,-1,22HROUNDS FIRED IN 1 SEC.,   P0655     381
     * NLT)                                                             P0655     382
      ENCODE(5,395,OUT) RPS                                             P0655     383
      CALL RITE2V(425,1009,1023,90,1,5,1,OUT,NLT)                       P0655     384
      CALL RITE2V(693,990,1023,90,1,10,-1,10HDIVE ANGLE,NLT)            P0655     385
  393 FORMAT(F5.1)                                                      P0655     386
      ENCODE(5,393,OUT) DIVE                                            P0655     387
      CALL RITE2V(836,990,1023,90,1,5,1,OUT,NLT)                        P0655     388
      CALL RITE2V(126,971,1023,90,1,47,-1,47HBALLISTIC DISP.       RANG P0655     389
     XE,         DEFLECTION,NLAST)                                      P0655     390
      CALL RITE2V(126,952,1023,90,1,41,-1,41HAIM ERROR       RANGE,     P0655     391
     X    DEFLECTION,NLAST)                                             P0655     392
      CALL RITE2V(576,1009,1023,90,1,21,-1,21HAIR SPEED       KNOTS,NLT)P0655     393
      ENCODE(5,395,OUT) C                                               P0655     394
      CALL RITE2V(706,1009,1023,90,1,5,1,OUT,NLT)                       P0655     395
      ENCODE(5,396,OUT) SIGR                                            P0655     396
      CALL RITE2V(269,952,1023,90,1,5,1,OUT,NLT)                        P0655     397
      ENCODE(5,396,OUT) SIGD                                            P0655     398
      CALL RITE2V(451,952,1023,90,1,5,1,OUT,NLT)                        P0655     399
      ENCODE(5,396,OUT) BETAR                                           P0655     400
      CALL RITE2V(347,971,1023,90,1,5,1,OUT,NLT)                        P0655     401
      ENCODE(5,396,OUT) BETAD                                           P0655     402
      CALL RITE2V(529,971,1023,90,1,5,1,OUT,NLT)                        P0655     403
```

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      CALL RITE2V(126,390,1023,90,1,3?,-1,35HSTEADY FIRE RATE          RO
     (UNDS/MIN,NLAST)
      ENCODE(7,397,OUT) F
      CALL RITE2V(347,990,1023,90,1,7,1,OUT,NLT)
      IF(IPLOT.EQ.1) CALL RITE2V(30,600,70,90,1,1,-1,1HP,NLAST)
      CALL RITE2V(43,590,70,90,1,1,-1,1HK,NLAST)
      CALL RITE2V(356,36,1023,90,1,21,-1,21HSLANT RANGE OPEN FIRE,NLT)
C
C....   PLOT ONE CURVE FOR EACH BURST LENGTH.
      IJ=1
      IF(IPLOT.EQ.1) GO TO 347
C
C....   ADDITIONAL HEADER INFORMATION FOR STAND-ALONE PLOTS.
      IF(TCODE.EQ.TARG4) GO TO 1006
      CALL RITE2V(30,600,70,90,1,1,-1,1HP,NLAST)
      GO TO 1007
 1006 CALL RITE2V(30,600,70,90,1,1,-1,1HF,NLAST)
 1007 CALL RITE2V(126,933,1023,90,1,34,-1,34HTARGET CODE      ,     WEAP
     XON CODE,NLT)
      CALL RITE2V(282,933,1023,90,1,5,1,TCODE,NLT)
      CALL RITE2V(581,933,1023,90,1,5,1,WCODE,NLT)
      CALL RITE2V(126,914,1023,90,1,41,-1,41HBURST LENGTH       ,   TOTA
     XL ROUNDS FIRED,NLT)
      ENCODE(5,396,OUT) BURSTL
      CALL RITE2V(295,914,1023,90,1,5,1,OUT,NLT)
      ENCODE(5,395,OUT) RNDSTL
      CALL RITE2V(672,914,1023,90,1,5,1,OUT,NLT)
      GO TO 1003
C
  347 CONTINUE
      REWIND 8
      DO 350 KK=1,NCASES
      READ (8) S,(PKPLOT(L),L=1,NTS)
      IF(EOF(8).NE.0.0)  GO TO 400
      CPK(KK) = PKPLOT(IJ)
      SLR(KK) = S
  350 CONTINUE
  351 CALL APLOTV(NCASES,SLR,CPK,1,1,1,38,IEROR)
      L=NCASES-1
      DO 348 KJ=1,L
      CALL LINEV(NXV(SLR(KJ)),NYV(CPK(KJ)),NXV(SLR(KJ+1)),
     X  NYV(CPK(KJ+1)))
  348 CONTINUE
C
C....   LABEL EACH CURVE WITH BURST LENGTH AND ROUNDS FIRED.
      IX=IXV(SLR(1))-35
      IY=IYV(CPK(1))-30
      IF(IPLOT.EQ.1) GO TO 349
      CALL PRINTV(10,PTITLE,IX,IY+16)
      GO TO 1003
  349 CONTINUE
      CALL PRINTV(-4,4HSECS,IX+48,IY)
      CALL PRINTV(-4,4HRNDS,IX+48,IY-16)
      ENCODE(5,396,OUT)  TPLOT(IJ)
      CALL PRINTV(5,OUT,IX,IY)
      ENCODE(5,395,OUT) RPS1(IJ)
      CALL PRINTV(5,OUT,IX,IY-16)
      IJ=IJ+1
      IF(IJ.LE.NTS) GO TO 347
      REWIND 8
      GO TO 11
C
C....   THIS SECTION HANDLES THE STAND-ALONE PLOT OPTION.
C
 1000 SMAX = 7000.0
```

```
      DO 1001 I=1,6                                                     P0655     469
 1001 SLR(I) = 1000.0*FLOAT(I)                                          P0655     470
      NCASES = 6                                                        P0655     471
 1002 READ(4,5000) TCODE,WCODE,RPS,C,R,DIVE,BURSTL,RNDSTL               P0655     472
      IF(EOF(4).NE.0.0)  GO TO 400                                      P0655     473
      READ(4,5001) SIGR,SIGD,BETAR,BETAD                                P0655     474
      IF(EOF(4).NE.0.0)  GO TO 400                                      P0655     475
 5000 FORMAT(2A5,6F10.0)                                                P0655     476
 5001 FORMAT(6F10.0,A10)                                                P0655     477
      CALL SETMIV(74,35,65,121)                                         P0655     478
      GO TO 398                                                         P0655     479
C                                                                       P0655     480
C****     BRANCH TO PLOT SEQUENCE AND RETURN HERE.                      P0655     481
 1003 READ(4,5001) (CPK(I),I=1,6),PTITLE                                P0655     482
      IF(EOF(4).NE.0.0)  GO TO 400                                      P0655     483
      IF(CPK(1)) 1002,1002,351                                          P0655     484
C                                                                       P0655     485
  405 WRITE(6,410)                                                      P0655     486
  410 FORMAT(*1I/P CAN NOT BE GENERATED UNLESS IPLOT = 1 OR 0*)         P065501    17
  400 CALL EXIT                                                         P0655     488
  511 CONTINUE                                                          P0655     489
      END                                                               P0655     490
```

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SUBROUTINE RANG        74/74    OPT=1                         FTN 4.5+410         22/07/76  14.32.33        PAGE     1

                  SUBROUTINE RANG(X,Y)                                                P065501    18
                  R=SQRT(-2.0*ALOG(RANF(-1)))                                         P065501    19
                  A=6.2831853 * RANF(-1)                                              P065501    20
                  X=R*COS(A)                                                          P065501    21
                  Y=R*SIN(A)                                                          P065501    22
                  RETURN                                                              P065501    23
                  END                                                                 P065501    24
```

```
      SUBROUTINE LOOKUP(X,Y,X0,N,OUT,J)                                 P0655   499
      DIMENSION X(N),Y(N)                                               P0655   500
C                                                                       P0655   501
C                                                                       P0655   502
C     THIS IS A ONE-DIMENSIONAL TABLE LOOKUP ROUTINE.                   P0655   503
C                                                                       P0655   504
C                                                                       P0655   505
      IF(J.GT.N) J=N                                                    P0655   506
      IF(J .LT. 1) J=1                                                  P0655   507
      I=J                                                               P0655   508
      IF(X0-X(I)) 10,20,30                                              P0655   509
   20 OUT=Y(I)                                                          P0655   510
      RETURN                                                            P0655   511
   10 IF(I.EQ.1) GO TO 20                                               P0655   512
      I=I-1                                                             P0655   513
      IF(X0-X(I)) 10,20,25                                              P0655   514
   30 IF(I.EQ.N) GO TO 20                                               P0655   515
      I=I+1                                                             P0655   516
      IF(X0-X(I)) 500,20,30                                             P0655   517
   25 I=I+1                                                             P0655   518
  500 OUT=Y(I-1)+((X0-X(I-1))/(X(I)-X(I-1)))*(Y(I)-Y(I-1))              P0655   519
      RETURN                                                            P0655   520
      END                                                               P0655   521
```

```
      OVERLAY(AFILE,2,0)                                                  P0655     540
      PROGRAM GENIP                                                       P0655     541
      DIMENSION AIM(12),BALE(12),VEL(12),TGTL(12),TGTW(12),CKILL( 6,10),  P0655     542
     1SLRNG(10,6),HCLL(10,7),DD(20),TIME(30),RD(30),INUM(20),NSLT(10)     P0655     543
     2,TPLOT(10)                                                          P0655     544
      COMMON/ENDDT/IEOF,ITEST,IGO,JIM,IPLOT,IOPT,NTS,TPLOT                P0655     545
      COMMON CKILA(240,10),K3,K4,ITGTL,CKILL,M                            P0655     546
     1,NOSLT                                                              P065501    25
      ASSIGN 1111 TO IEOF                                                 P0655     547
      WRITE(6,50)                                                         P0655     548
   50 FORMAT(///* THE FOLLOWING IS A LIST OF PARAMETERS USED TO GENERATE  P0655     549
     1 I/P*/)                                                             P0655     550
      READ(5,100)IAIM,AIM                                                 P0655     551
      IF(EOF(5).NE.0.0)  GO TO 2227                                       P0655     552
      WRITE(6,51)IAIM,AIM                                                 P0655     553
   51 FORMAT(11X,*IAIM  STANDARD DEVIATION OF AIMING ERROR TABLE*,/,12X,  P0655     554
     2I2,3X,12F5.2,/)                                                     P0655     555
      IFLAG = 0                                                           P0655     556
      ITH = 3                                                             P0655     557
      IFOUR = 4                                                           P0655     558
      IFIVE = 5                                                           P0655     559
      ISIX = 6                                                            P0655     560
      ISEV = 7                                                            P0655     561
      ININE = 9                                                           P0655     562
      IELEV = 11                                                          P0655     563
      ITWEL = 12                                                          P0655     564
      ITHIR = 13                                                          P0655     565
      M = 6                                                               P0655     566
  100 FORMAT(I2,3X,12F5.0)                                                P0655     567
      READ(5,100)IBALE,BALE                                               P0655     568
      IF(EOF(5).NE.0.0)  GO TO 2227                                       P0655     569
      WRITE(6,52)IBALE,BALE                                               P0655     570
   52 FORMAT(11X,*IBALE  STANDARD DEVIATION OF THE BALLISTIC ERROR TABLE  P0655     571
     1*,/,12X,I2,3X,12F5.2,/)                                             P0655     572
      WRITE(6,57)                                                         P0655     573
      READ(5,100)IVEL,VEL                                                 P0655     574
      IF(EOF(5).NE.0.0)  GO TO 2227                                       P0655     575
      WRITE(6,53)IVEL,(VEL(I),I=1,IVEL)                                   P0655     576
   53 FORMAT(11X,*IVEL  AIRCRAFT SPEED TABLE*,/,12X,I2,3X,12F5.0)         P0655     577
      WRITE(6,57)                                                         P0655     578
      READ(5,100)ITGTL,TGTL                                               P0655     579
      IF(EOF(5).NE.0.0)  GO TO 2227                                       P0655     580
      WRITE(6,54)ITGTL,(TGTL(I),I=1,ITGTL)                                P0655     581
   54 FORMAT(11X,*ITGTL  TARGET LENGTH TABLE*,/,12X,I2,3X,12F5.2)         P0655     582
      WRITE(6,57)                                                         P0655     583
      READ(5,100)ITGTW,TGTW                                               P0655     584
      IF(EOF(5).NE.0.0)  GO TO 2227                                       P0655     585
      WRITE(6,55)ITGTW,(TGTW(I),I=1,ITGTW)                                P0655     586
   55 FORMAT(11X,*ITGTW  TARGET WIDTH TABLE*,/,12X,I2,3X,12F5.2)          P0655     587
      WRITE(6,57)                                                         P0655     588
      READ(5,110) IKILL,(CKILA(1,J),J=1,10)                               P0655     589
      IF(EOF(5).NE.0.0)  GO TO 2227                                       P0655     590
  110 FORMAT(I2,3X,10F5.0)                                                P0655     591
      IF(IKILL-1) 180,180,182                                             P0655     592
  182 READ(5,184) ((CKILA(I,J),J=1,10),I=2,IKILL)                         P0655     593
      IF(EOF(5).NE.0.0)  GO TO 2227                                       P0655     594
  184 FORMAT(5X,10F5.0)                                                   P0655     595
  180 CONTINUE                                                            P0655     596
      DO 700 I = 1,IKILL                                                  P065501    26
      DO 700 J = 1,10                                                     P0655     598
      IF(CKILA(I,J) .EQ. 0.)CKILA(I,J) = 0.                               P0655     599
  700 CONTINUE                                                            P0655     600
      DO 750 J = 1,10                                                     P0655     601
      DO 750 I = 1,IKILL                                                  P065501    27
  750 CKILL(I,J) = CKILA(I,J)                                             P0655     603
```

```
      WRITE(6,56) IKILL,((CKILL(I,J),J=1,10),I=1,IKILL)                P0655      604
   56 FORMAT(11X,*IKILL  CONDITIONAL KILL TABLE*,/,12X,I2,3X,2F5.1,8F5.3 P0655      605
     1,/(17X,2F5.1,8F5.3))                                             P0655      606
   57 FORMAT(/ )                                                       P0655      607
      WRITE(6,57)                                                      P0655      608
      READ(5,128)ISLRG,NSLT(1),(SLRNG(1,J),J=1,6)                      P0655      609
C     ASSUME FOR A PARTICULAR COMPUTER RUN, ONLY ONE GROUP OF SLANT RANG P065501     28
      NOSLT = NSLT(1)                                                  P065501     29
      M = NOSLT                                                        P065501     30
      IF(EOF(5).NE.0.0)  GO TO 2227                                    P0655      610
  128 FORMAT(2I5,6F10.0)                                               P0655      611
      WRITE(6,58) ISLRG,NSLT(1),(SLRNG(1,J),J=1,6)                     P0655      612
   58 FORMAT(11X,*ISLRG NSLT    SLANT RANGE TABLE*,/ 9X,2I5,6F10.0)    P0655      613
      IF(ISLRG .EQ. 1) GO TO 126                                       P0655      614
C     CURRENTLY THIS PROGRAM IS DESIGNED TO HANDLE ONLY ONE GROUP OF   P065501     31
C     SLANT RANGES (ISLRG ALWAYS EQUALS ONE).                          P065501     32
      DO 125 I = 2,ISLRG                                               P0655      615
      READ (5,121) NSLT(I),(SLRNG(I,J),J=1,6)                          P0655      616
      IF(EOF(5).NE.0.0)  GO TO 2227                                    P0655      617
  121 FORMAT(5X,I5,6F10.0)                                             P0655      618
      WRITE(6,59) NSLT(I),(SLRNG(I,J),J=1,6)                           P0655      619
   59 FORMAT(14X,I5,6F10.0)                                            P0655      620
  125 CONTINUE                                                         P0655      621
  126 WRITE(6,57)                                                      P0655      622
  128 READ (5,130)((HOLL(I,J),J=1,7),I=1,ISLRG)                        P0655      623
      IF(EOF(5).NE.0.0)  GO TO 2227                                    P0655      624
  130 FORMAT(6A10,F10.0)                                               P0655      625
      WRITE(6,60)((HOLL(I,J),J=1,7),I=1,ISLRG)                         P0655      626
   60 FORMAT(11X,*HOLLERITH INFORMATION -- 1 HOLLERITH CARD PER GROUP OF P0655      627
     1 SLANT RANGES*,/,(12X,6A10,F10.0))                               P0655      628
      ASSIGN 2226 TO IEOF                                              P0655      629
      KSTOP = (IVEL*ITGTL)*NOSLT                                       P065501     33
      IST = NOSLT+1                                                    P065501     34
      READ(5,184)  ((CKILA(I,J),J=1,10),I=IST,KSTOP)                   P065501     35
      IF(EOF(5).NE.0.0)  GO TO 2227                                    P0655      632
 4995 FORMAT(*0ADDITIONAL I/P GENERATED WITH PREVIOUS TABLES BEING REPLA P0655      633
     1CED BY THESE TABLES*/)                                           P0655      634
      ASSIGN 4997 TO IEOF                                              P0655      635
      READ(5,110) ENDDATA                                              P0655      636
      IF(EOF(5).NE.0.0)  GO TO 2227                                    P0655      637
      GO TO 2226                                                       P0655      638
 4997 WRITE(6,4995)                                                    P0655      639
      DO 880 I = IST,KSTOP                                             P065501     36
      DO 880 J = 1,10                                                  P0655      641
      IF(CKILA(I,J) .EQ. 0.) CKILA(I,J)=0.                             P0655      642
  880 CONTINUE                                                         P0655      643
      DO 890 II = IST,KSTOP,NOSLT                                      P065501     37
      IK = II+NOSLT-1                                                  P065501     38
      WRITE(6,56) IKILL,((CKILA(IJ,J),J=1,10),IJ=II,IK)                P0655      646
      WRITE(6,57)                                                      P0655      647
  890 CONTINUE                                                         P0655      648
    5 READ(4,2)L,PRMTR,PM2                                             P0655      649
      IF(EOF(4).NE.0.0)  GO TO 2227                                    P0655      650
      IF(L .GT. 0) INUM(L)=L                                           P0655      651
    2 FORMAT(I2,F8.0,F10.0)                                            P0655      652
      IF(L .EQ. 20) GO TO 20                                           P0655      653
      IF(L)7,7,6                                                       P0655      654
    6 DO(L) = PRMTR                                                    P0655      655
      GO TO 5                                                          P0655      656
   20 JIM = PRMTR                                                      P0655      657
      DO(L) = PRMTR                                                    P0655      658
      IF(JIM .NE. 1) GO TO 5                                           P0655      659
      READ(4,9)NOT,(RD(I),I=1,NOT)                                     P0655      660
      IF(EOF(4).NE.0.0)  GO TO 2227                                    P0655      661
      READ(4,10)(TIME(I),I=1,NOT)                                      P0655      662
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      IF(EOF(4).NE.0.0)  GO TO 2227                                 P0655     663
      GO TO 5                                                       P0655     664
    9 FORMAT(I5/(10F8.2))                                           P0655     665
   10 FORMAT(16F5.4)                                                P0655     666
    7 CONTINUE                                                      P0655     667
      REWIND 4                                                      P0655     668
C  ESTABLISH 1ST CASE -- CARD TYPES 1,2,8,10,14-20,23A,23B,         P0655     669
C  AND 23C WILL ONLY BE WRITTEN ONCE.                               P0655     670
   35 FORMAT(*1GENERATED I/P*,//)                                   P0655     671
      IF(IPLOT .EQ. 1) WRITE(4,38)NSLT(1)                           P065501    39
   38 FORMAT(I5)                                                    P0655     673
      WRITE(4,31)  (HOLL(1,J),J=1,7)                                P0655     674
    3 FORMAT(I2,F8.2,F10.2)                                         P0655     675
   13 FORMAT(I2,F8.4,F10.2)                                         P0655     676
   31 FORMAT(6A10,F10.0)                                            P0655     677
      WRITE(4,3)INUM(1),DD(1)                                       P0655     678
      WRITE(4,3)INUM(2),DD(2)                                       P0655     679
      WRITE(4,3)ITH,AIM(1),AIM(2)                                   P0655     680
      WRITE(4,3)IFOUR,AIM(3),AIM(4)                                 P0655     681
      WRITE(4,3)IFIVE,BALE(1)                                       P0655     682
      WRITE(4,3)ISIX,BALE(2)                                        P0655     683
      WRITE(4,3)ISEV,SLRNG(1,1)                                     P0655     684
      WRITE(4,3)INUM(8),DD(8)                                       P0655     685
      WRITE(4,3)ININE,VEL(1)                                        P0655     686
      WRITE(4,3)INUM(10),DD(1))                                     P0655     687
      WRITE(4,3)IELEV,CKILL(1,1)                                    P0655     688
      IFIN = IFIX(CKILL(1,1))                                       P0655     689
      DO 45 I = 1,IFIN                                              P0655     690
      II = 3*I-1                                                    P0655     691
      ISP = IFIX(CKILL(1,II))                                       P0655     692
   45 WRITE(4,26)   ISP,CKILL(1,II+1),CKILL(1,II+2)                 P0655     693
   26 FORMAT(I5,2F10.3)                                             P0655     694
      WRITE(4,3)ITWEL,TGTL(1)                                       P0655     695
      WRITE(4,3)ITHIR,TGTW(1)                                       P0655     696
      DO 48 I = 14,20                                               P0655     697
      IF (I .EQ. 17 .OR. I .EQ. 18) WRITE(4,13) INUM(I),DD(I)       P0655     698
      IF(I .EQ. 17 .OR. I .EQ. 18) GO TO 48                         P0655     699
      WRITE(4,3)INUM(I),DD(I)                                       P0655     700
   48 CONTINUE                                                      P0655     701
      IF(JIM .NE. 1) GO TO 65                                       P0655     702
      WRITE(4,39)NOT,(RD(I),I=1,NOT)                                P0655     703
      WRITE(4,40)  (TIME(I),I=1,NOT)                                P0655     704
   39 FORMAT(I5/(10F8.2))                                           P0655     705
   40 FORMAT(16F5.2)                                                P0655     706
   65 WRITE(4,2)                                                    P0655     707
C                                                                   P0655     708
      NSLRN = NSLT(1)                                               P0655     709
      DO 70 I = 2,NSLRN                                             PC655     710
      WRITE(4,31 )(HOLL(I,J),J=1,7)                                 P0655     711
      WRITE(4,3)ISEV,SLRNG(1,I)                                     P0655     712
      WRITE(4,3) IELEV,CKILL(I,1)                                   P0655     713
      IFIN = IFIX(CKILL(I,1))                                       P0655     714
      DO 67 L = 1,IFIN                                              P0655     715
      II = 3*L - 1                                                  P0655     716
      ISP = IFIX(CKILL(I,II))                                       P0655     717
   67 WRITE(4,26) ISP,CKILL(I,II+1),CKILL(I,II+2)                   P0655     718
      WRITE(4,2)                                                    P0655     719
   70 CONTINUE                                                      P0655     720
      IF (IFLAG .EQ. 1) GO TO 88                                    P0655     721
      K1 = 1                                                        P0655     722
      K2 = 1                                                        P0655     723
      K2YES = 0                                                     P0655     724
      K3 = 1                                                        P0655     725
      K3YES = 0                                                     P0655     726
      K4 = 1                                                        P0655     727
```

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      K4YES = 0                                                         P0655      728
      K5 = 1                                                            P0655      729
      IBIG = 1                                                          P0655      730
      IFLAG = 1                                                         P0655      731
      GO TO 88                                                          P0655      732
   91 IF(IPLOT .EQ. 1) WRITE(4,38)NSLT(1)                               P065501     40
      WRITE(4,31) (HOLL(1,J),J=1,7)                                     P0655      734
      II = 4*K1-3                                                       P0655      735
      WRITE(4,3)ITH,AIM(II),AIM(II+1),IFOUR,AIM(II+2),AIM(II+3)         P0655      736
      IF(IBALE .GT. 1) K2YES = 1                                        P0655      737
      IF(K2YES .EQ. 1) GO TO 116                                        P0655      738
      GO TO 118                                                         P0655      739
   93 K2YES = 1                                                         P0655      740
      IF(IPLOT .EQ. 1) WRITE(4,38)NSLT(1)                               P065501     41
      WRITE(4,31) (HOLL(1,J),J=1,7)                                     P0655      742
  116 II = 2*K2-1                                                       P0655      743
      WRITE(4,37) IFIVE,BALE(II),ISIX,BALE(II+1)                        P0655      744
      K2YES = 0                                                         P0655      745
  118 WRITE(4,3) ISEV,SLRNG(1,1)                                        P0655      746
      IF(IVEL .GT. 1) K3YES = 1                                         P0655      747
      IF(ITGTL .GT. 1) K4YES = 1                                        P0655      748
      IF(K3YES .EQ. 1) GO TO 108                                        P0655      749
      GO TO 99                                                          P0655      750
   94 K3YES = 1                                                         P0655      751
      IF(ITGTL .GT. 1) K4YES = 1                                        P0655      752
      IF(IPLOT .EQ. 1) WRITE(4,38)NSLT(1)                               P065501     42
      WRITE(4,31) (HOLL(1,J),J=1,7)                                     P0655      754
      WRITE(4,3) ISEV,SLRNG(1,1)                                        P0655      755
  108 WRITE(4,3) ININE,VEL(K3)                                          P0655      756
      K3YES = 0                                                         P0655      757
      GO TO 99                                                          P0655      758
   96 K4YES = 1                                                         P0655      759
      IF(IPLOT .EQ. 1) WRITE(4,38)NSLT(1)                               P065501     43
      WRITE(4,31) (HOLL(1,J),J=1,7)                                     P0655      761
      WRITE(4,3) ISEV,SLRNG(1,1)                                        P0655      762
      GO TO 99                                                          P0655      763
  107 K4YES = 0                                                         P0655      764
      WRITE(4,37)ITWEL,TGTL(K4),ITHIR,TGTH(K4)                          P0655      765
      GO TO 65                                                          P0655      766
   37 FORMAT(I2,F8.2)                                                   P0655      767
   99 WRITE(4,3)IELEV,CKILL(K5,1)                                       P0655      768
      IFIN = IFIX(CKILL(K5,1))                                          P0655      769
      DO 85 I = 1,IFIN                                                  P0655      770
      II = 3*I-1                                                        P0655      771
      ISP=IFIX(CKILL(K5,II))                                            P0655      772
   85 WRITE(4,26) ISP,CKILL(K5,II+1),CKILL(K5,II+2)                     P0655      773
      GO TO 107                                                         P0655      774
   88 IF (ISLRG .EQ. 1) GO TO 1000                                      P0655      775
      DO   95 K6 = IBIG,ISLRG                                           P0655      776
      IF(IPLOT .EQ. 1) WRITE(4,38)NSLT(K6)                              P065501     44
      NSLRN=NSLT(K6)                                                    P0655      778
      DO 95 I = 1,NSLRN                                                 P0655      779
      WRITE(4,31 )(HOLL(K6,J),J=1,7)                                    P0655      780
      WRITE(4,3)ISEV,SLRNG(K6,I)                                        P0655      781
      WRITE(4,3) IELEV,CKILL(I,1)                                       P0655      782
      IFIN = IFIX(CKILL(I,1))                                           P0655      783
      DO 92 L = 1,IFIN                                                  P0655      784
      II = 3*L - 1                                                      P0655      785
      ISP = IFIX(CKILL( I,II))                                          P0655      786
   92 WRITE(4,26) ISP,CKILL(I,II+1),CKILL(I,II+2)                       P0655      787
      WRITE(4,2)                                                        P0655      788
   95 CONTINUE                                                          P0655      789
 1000 CONTINUE                                                          P0655      790
      K4 = K4+1                                                         P0655      791
      IF(K4 .LE. ITGTL) CALL INSERT                                     P0655      792
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      IF(K4 .LE. ITGTL) GO TO 96                                        P0655     793
      K5 = 1                                                            P0655     794
      K4 = 1                                                            P0655     795
      K3 = K3+1                                                         P0655     796
      IF(K3 .LE. IVEL) CALL INSERT                                      P0655     797
      IF(K3 .LE. IVEL) GO TO 94                                         P0655     798
      K5 = 1                                                            P0655     799
      K4 = 1                                                            P0655     800
      K3 = 1                                                            P0655     801
      K2 = K2+1                                                         P0655     802
      IF(K2 .GT. IBALE) GO TO 4860                                      P0655     803
      DO 4850 J = 1,10                                                  P0655     804
      DO 4850 I = 1,M                                                   P065501    45
 4850 CKILL(I,J) = CKILA(I,J)                                           P0655     806
      M = NOSLT                                                         P065501    46
      GO TO 93                                                          P0655     808
 4860 CONTINUE                                                          P0655     809
      K5=1                                                              P0655     810
      K4=1                                                              P0655     811
      K3=1                                                              P0655     812
      K2=1                                                              P0655     813
      K1 = K1+1                                                         P0655     814
      IF (K1 .GT. IAIM) GO TO 4980                                      P0655     815
      DO 4900 J = 1,10                                                  P0655     816
      DO 4900 I = 1,M                                                   P065501    47
 4900 CKILL(I,J) = CKILA(I,J)                                           P0655     818
      M = NOSLT                                                         P065501    48
      GO TO 91                                                          P0655     820
 4980 CONTINUE                                                          P0655     821
 1001 REWIND 4                                                          P0655     822
      WRITE(6,35)                                                       P0655     823
      GO TO 1114                                                        P0655     824
 1111 WRITE(6,1113)                                                     P0655     825
 1113 FORMAT(*1ERROR IN I/P -- EOF READ WHILE TRYING TO READ I/P DATA*,/ P0655     826
     1* OR, DATA READ WHEN ATTEMPTING TO READ AN EOR*)                  P0655     827
      GO TO 2222                                                        P0655     828
 1114 ASSIGN 1125 TO IEOF                                               P0655     829
 1119 READ(4,1112)(NSLT(I),I=1,8)                                       P0655     830
      IF(EOF(4).NE.0.0)  GO TO 2227                                     P0655     831
 1112 FORMAT(8A10)                                                      P0655     832
      WRITE(6,1115)(NSLT(I),I=1,8)                                      P0655     833
 1115 FORMAT(12X,8A10)                                                  P0655     834
      GO TO 1119                                                        P0655     835
 1125 REWIND 4                                                          P0655     836
      GO TO 2223                                                        P0655     837
 2227 GO TO IEOF(1111,2226,4997,1125)                                   P0655     838
 2226 WRITE(6,2228)                                                     P0655     839
 2228 FORMAT(*1ERROR IN I/P--EOF OR EOR READ WHILE TRYING TO READ IN CKI P0655     840
     1LL TABLES.*/*0OR EXCESS CKILL TABLES IN SET-UP.*)                 P0655     841
 2222 CALL EXIT                                                         P0655     842
 2223 CONTINUE                                                          P0655     843
      END                                                               P0655     844
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SUBROUTINE INSERT      74/74    OPT=1                      FTN 4.5+410        22/07/76  14.32.33       PAGE     1

                SUBROUTINE INSERT                                                  P0655       845
                DIMENSION CKILL(6,10)                                              P0655       846
                COMMON CKILA(240,10),K3,K4,ITGTL,CKILL,M                           P0655       847
               1,NOSLT                                                             P065501      49
                DO 900 JJ = 1,NOSLT                                                P065501      50
                M = M + 1                                                          P0655       849
                DO 900 I = 1,10                                                    P0655       850
                CKILL(JJ,I) = CKILA(M,I)                                           P0655       851
            900 CONTINUE                                                           P0655       852
                RETURN                                                             P0655       853
                END                                                                P0655       854
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